OWNER'S MANUAL

DS·300·T3
DS·500·T3
DS·520·T3

DIGITAL THERMOCOUPLE INDICATOR

DORIC SCIENTIFIC CORPORATION

WARRANTY

Doric Scientific Corporation hereby warrants each instrument of its manufacture as follows:

1. At the time of delivery of each instrument to the original purchaser, Doric Scientific Corp. UNCONDITIONALLY WARRANTS that it shall be free from defects in parts, materials and workmanship; and

2. Commencing with the date of shipment of each instrument to the original purchaser, Doric Scientific UNCONDITIONALLY WARRANTS that each unit shall remain free from defect in parts, materials and workmanship for the period specified below.

In the event any instrument fails to meet the terms of this warranty, Doric Scientific Corp. agrees to provide corrective action. Refer to the Owner's manual for the proper procedure.

The warranties herein shall not obligate Doric Scientific Corp. in any manner whatsoever with respect to, and shall not be applicable to, any defects which after an inspection by Doric Scientific Corp. are not to Doric Scientific Corp.'s reasonable satisfaction demonstrably the result of defective parts, materials or workmanship. We are not liable for consequential damages.

5-Year Warranty: DS100-K Series; DS100-P Series

2-Year Warranty: DS100-T Series; DS300-T3; DS500-T3; DS350-T3; DS300-T2

1-Year Warranty: Digitrend Series; DS520-T3

CERTIFICATION

Doric Scientific certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when shipped from the factory. Doric Scientific further certifies that its calibration measurements are traceable to NBS.

DORIC SCIENTIFIC CORPORATION...THE ONLY THING FOR SOME PEOPLE.
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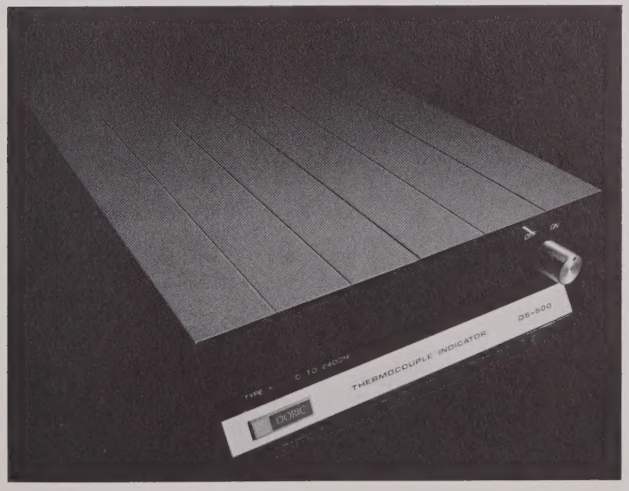
FOREWORD

This manual describes, in detail, all aspects of operation pertaining to the Doric Scientific DS300-T3, DS500-T3 and DS520-T3 line of thermocouple indicators.

In the interest of simplification, the text will refer only to a DS300-T3 unless differences in operation warrant separate definitions of the models. When differences do occur, complete details will be given for each model.



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section 1

description

1.1 GENERAL DESCRIPTION

The Doric Scientific DS300-T3 is a fully automatic, solid-state measuring instrument which, after proper signal conditioning, displays the outputs of a wide variety of thermocouples directly in °F or °C.

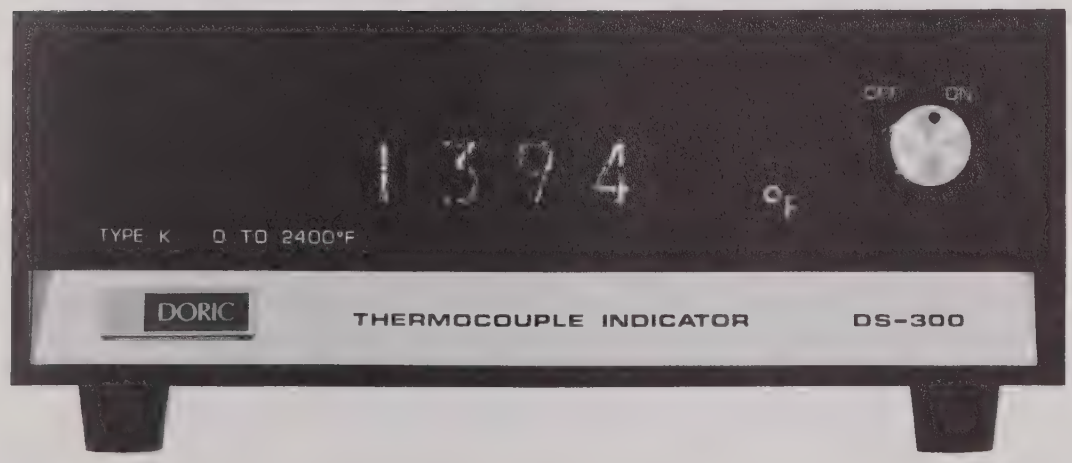


FIG. 1-1 DS300-T3

The instrument includes a microvolt level A/D converter; direct nixie display and internal reference junction compensation. Automatic thermocouple break detection is also standard.

The DS300-T3 is normally wired to operate from a 115 ±10% VAC, 50 - 400 Hz power source but may also be wired for 230 volt operation.

A .25 Amp SLO-BLO power fuse is used for 115V operation; a .125 Amp SLO-BLO power fuse for 230V. A 2 Amp SLO-BLO Pigtail fuse protects the I. C. Supply. This fuse is located on the rear of the motherboard.

Dependent upon full scale requirements, three or four high intensity nixie tubes form the in-line readout, providing a sharp display of the digits and decimal point. Storage circuits hold the display constant between and during encoding, eliminating blanking, blurring and last digit flutter.

In the event that the instrument is being overloaded by an excessive voltage input, the nixie display will begin flashing and blurring. When the input level has been corrected, normal display will return.

If the thermocouple input has opened, the nixies will exhibit the same symptoms as an overload condition, making it impossible to read the display. Once the open is corrected, normal readout will resume.

A "—" symbol on the readout indicates the minus, or negative, polarity. Absence of the symbol indicates a plus, or positive, polarity.

The overflow "one" is a neon lamp.

The DS300 has an illuminated symbol block. The DS500 and DS520 degree symbol is engraved on the front panel.

1.2 EXTERNAL CONTROLS

1.2.1 Power Switch

On the DS300 and DS500-T3, power is applied to the instrument by moving the rotary switch located on the front panel from the OFF to the ON position. The DS520 has no switch. It becomes fully operational by plugging in the AC power cord.

1.2.2 Multipoint Pushbuttons

If the thermocouple indicator is purchased with option ISC-12, it will have a 1½" lower box permanently attached to the standard chassis. (See Figure 1-4.) This box houses the 12 channel

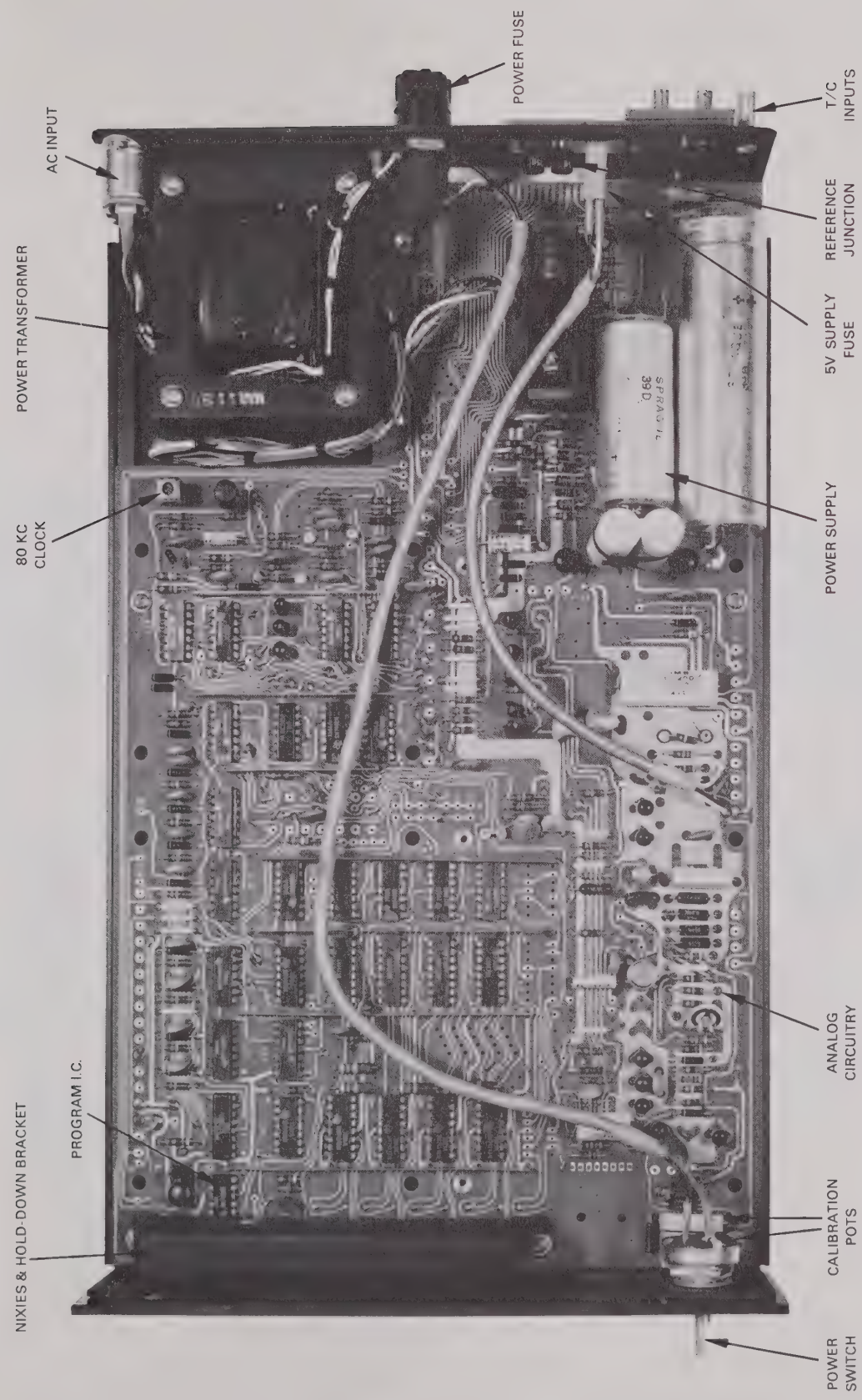


FIG. 1-2 MAJOR COMPONENTS

switchboard on which are mounted 12 pushbuttons. Each button controls the selection of a particular thermocouple. Depression of a button selects that given thermocouple's temperature for display on the readout. (To disengage a pushbutton, push all the way in and release.) When two or more buttons are depressed, the instrument will display the "average" temperature of all those thermocouples being measured.

If the instrument has the external 12 or 24 button option, it will retain its 3 x 8.5 exterior dimensions. The pushbuttons will be housed in a separate 3 x 8.5 box. (See Figure 1-4.)

Wiring instructions for the multipoint selectors are described in Section II, paragraph 2.3.2.

FIG. 1-3 DS300-T3 REAR PANEL & SLIDE SHIELD

1.3 BCD OUTPUTS (Option S6P) — DS300; DS500; DS520

When isolated BCD outputs are installed, they are brought out to the rear of the instrument via a 36-pin Amphenol connector, J1. (See Figure 2-5 for pin information.) These outputs enable the instrument to interface with external elements for system usage. Remote sample command and readout "hold display" inputs are included.

The BCD outputs are positive true unless otherwise specified at time of purchase.

(See Section II, paragraph 2.3.4: Remote Programming.)

FIG. 1-4 MULTIPOINT VARIATIONS

1-4 DIGITAL SET POINT (Option S9) — DS300 only

When this option is installed, the front panel includes a pot and a pushbutton switch which are used in conjunction with each other to set limits on the temperature range which, when exceeded, will cause an alarm closure to be made.

The set point is arrived at by depressing the upper front panel pushbutton. This disconnects the input to the instrument and connects the readout to an internal reference. The pot, which is a ten-turn pot covering a span of approximately 200°, is then manually adjusted until the display in the readout is set at the desired limit. When the button is released, the input is reconnected. When the desired limit is exceeded, a relay closure triggers the alarm.

This option may also be used as an OFF-ON temperature controller by using the relay closure to control an SCR switching a heating element.

1.5 ANALOG OUTPUTS (Option S7) — DS300 only

When requested, a chopper-stabilized analog output is brought out to the rear of the instrument (J1). This output is normally intended to drive a floating analog indicator. (See Section II, paragraph 2.3.4.)

1.6 FEATURES/SPECIFICATIONS

The latest in the Doric family of digital temperature indicators, these 3 models of couple indicators monitor I-C, C-A, C-C or other thermocouple temperatures over the commonly used portions of their respective ranges with 1° resolution and repeatability and high accuracy.

Electronic digital techniques provide direct decimal display with no parallax or interpretation errors, faster speed with tracking display, superior solid-state reliability, no moving parts to wear, computer compatible outputs, elimination of noise susceptibility, jitter, dither, deadband, and backlash.

Total guarding techniques allow direct use with grounded or floating thermocouples, even with printer outputs grounded. High noise rejection of 120 db allows rock solid, stable display.

Auto-Zero, a Doric proprietary digitizing technique which eliminates preamplifiers and zero drift, and Doric's proprietary digital linearization technique all blend to provide a highly stable display, regardless of ambient temperature variation, frequency of re-calibration, and wide power line

variations. The linearizer never requires calibration. Only two pots are ever used for total instrument calibration: a two-minute job done once a year if you like.

Extensive use of MSI integrated circuits along with simplified second generation design allows total instrument construction on a single, heavy duty, glass epoxy PC board: an ideal concept for "O.E.M." or "private labeling." Extreme simplicity of design streamlines test labor and allows attractive discount structure for high quantity O.E.M. customers.

PERFORMANCE SPECIFICATIONS

INPUT CIRCUIT:

Guarded, differential; allowing grounded or floating sensors, even with grounded printout.

MEASUREMENT METHOD:

Auto-Zero, dual slope integration with potentiometric input. No zero foldover errors; E_X/E_{REF} switching ahead of input amplifier.

OVERLOAD:

±120 VDC continuous; 115 VAC line across input will not damage.

MAXIMUM SOURCE RESISTANCE:

Base Metals 3K

Noble Metals . . . 1K

LINEARIZATION:

100% digital with no analog approximation circuits, non-linear slidewires or other electro-mechanical/optical methods.

COMMON MODE REJECTION:

DS300: 120 db @ 59 Hz with 100Ω R_{unbal}, increasing 12 db/octave. 250 VDC or peak AC.

DS500: 110 db @ 59 Hz with 100Ω R_{unbal}, increasing 6 db/octave. 250 VDC or peak AC.

DS520: 100 db @ 59 Hz with 100Ω R_{unbal}, increasing 6 db/octave. 250 VDC or peak AC.

NORMAL OR SERIES MODE REJECTION:

DS300: 60 db @ 59 Hz, increasing 18 db/octave.

DS500 & DS520: 40 db @ 59 Hz, increasing 12 db/octave.

ZERO DRIFT:

None

CALIBRATION DRIFT:

DS300: Maximum ±1°F change in one year for base metals.

DS500, 520: Maximum ±2°F change in one year for base metals.

CIRCUITRY:

All silicon, solid-state; extensive use of MSI and LSI integrated circuits. Single card construction, 3/32" glass epoxy.

CALIBRATION:

2 points — zero and full scale; no need for individual segment calibration at any time. Extender card never required.

RESOLUTION & REPEATABILITY:

1°F or 1°C.

TEMPERATURE STABILITY:

DS300: ±.0025% RDG/°F ±0.5μv/°F

DS500: ±.02% of reading/°F ±0.5 microvolt/°F

DS520: ±.02% of reading/°F ±1.0 microvolt/°F

COLD JUNCTION COMPENSATION:

Automatic from 32°F to 122°F; stability of ±.05°F/°F around midpoint between 50 and 104°F.

THERMOCOUPLE BURNOUT DETECTION:

Open input causes instant blurring of Nixie display. Less than 1 digit of error with 3K thermocouple resistance. No flow of burnout detection current during sample time of instrument.

DISPLAY:

Nixies. Digital storage allows tracking without eye fatigue.

SAMPLE RATE:

3-4/sec. fixed (settable by resistor); integration: 100 ms.

POWER:

105-125 VAC, 50-400 Hz, 14 Watts

REMOTE HOLD:

Providing a closure between 2 pins on the rear causes the instrument to stop sampling and retain the reading in process indefinitely.

BCD OUTPUT OPTION:

Digital outputs may be grounded even when thermometer is used with grounded thermocouples with no loss of isolation or noise rejection characteristics; parallel 8-4-2-1 code, buffered, positive true logic; negative true available. Remove sample command input and print command output lines. Includes mating connector.

ANALOG OUTPUT OPTION: (DS300 only)

Buffered, linear output representation of compensated mv input signal. Nominal gain of x100; normally intended to drive a floating analog indicator or recorder.

DIGITAL SET-POINT OPTION: (DS300 only)

For alarm or limit set applications; a front panel, 10-turn pot allows setting the alarm temperature precisely by using the actual Nixie display in conjunction with a pushbutton. To allow ease of settability with the pot to the exact degree desired, the pot normally covers a span of ±100°F or °C. Moving the alarm range simply involves a resistor substitution on easily changeable terminals. Alarm output is a SPDT relay closure.

NON-STANDARD RANGES:

Refer to library of standard ranges available with Doric DS100-T3 thermometer. Many standard ranges are available in all TC types, °F, °C, °K and with 0.1° resolution and extremely high accuracies. Consult factory for availability of range of your interest.

OPERATING TEMPERATURE:

32-122°F normal; extended range available.

MANUAL:

One operating & maintenance handbook included.

SIZE:

3" H x 8.5" W x 14.5" D

SHIPPING WEIGHT:

15 lbs.

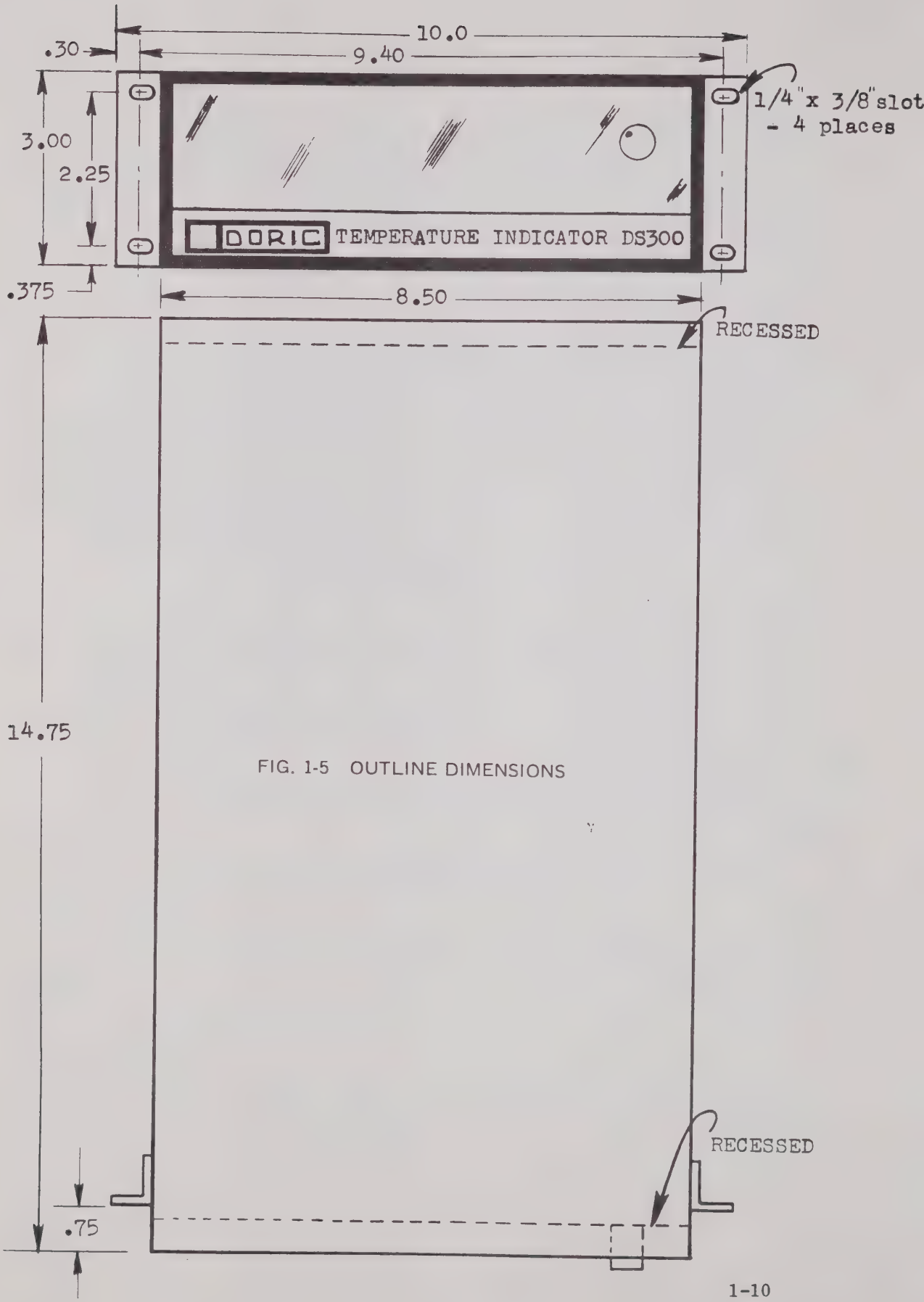


FIG. 1-5 OUTLINE DIMENSIONS

Accuracy:

DS-300(Standard Ranges)*

RANGE NO.	ISA TYPE	MATERIALS	RANGE	OVERALL CALIBRATION ACCURACY AT 77 ±5°F
E301	E	Chromel-Constantan	-100 to 1600°F	±3°F <300< ±1.5°F
J301	J	Iron-Constantan	-100 to 1595°F	±1.8°F <0 <±1°F
J302	J	Iron-Constantan	-50 to +800°C	±1.5°C <0 <1.2°C
K301	K	Chromel-Alumel	-100 to 2400°F	±2°F <0 <1.5°F
K302	K	Chromel-Alumel	-50 to 1370°C	±1.8°C
T301	T	Copper-Constantan	-310 to +750°F	±1.5°F> -100< ±2°F
T302	T	Copper-Constantan	-60 to +400°C	±1.5°C <40 <±1°C
R301	R	Platinum-Platinum/ 13% Rhodium	800 to 1600°C	±1°C
S301	S	Platinum-Platinum/ 10% Rhodium	800 to 1600°C	±1°C

DS500 Standard Ranges* = .25% of standard range

DS520 Standard Ranges* = ± 0.5% of reading. or ± 2°, whichever is larger

*Non-standard ranges, consult factory

STANDARD RANGES

Range No.	Thermocouple Type	Range
J301	Iron-Constantan	0 to +1595°F
J301B	Iron-Constantan	-100 to +1595°F*
J302	Iron-Constantan	0 to + 800°C
J302B	Iron-Constantan	-50 to + 800°C*
K301	Chromel-Alumel	0 to +2400°F
K301B	Chromel-Alumel	-100 to +2400°F*
K302	Chromel-Alumel	0 to 1370°C
K302B	Chromel-Alumel	-50 to +1370°C*
T301	Copper-Constantan	-310 to + 750°F
T302	Copper-Constantan	-60 to + 400°C
E301	Chromel-Constantan	0 to +1600°F
E301B	Chromel-Constantan	-100 to +1600°F*
R301	Platinum-Platinum-13% Rhodium	800 to 1600°C*
S301	Platinum-Platinum-10% Rhodium	800 to 1600°C*

*hese ranges are extra cost; consult rep or factory for exact prices.

section 2

installation

2.1 UNPACKING

Because of the ruggedized construction of the DS300-T3, little need be done to insure that the instrument has arrived free of shipping damage.

A cursory visual inspection of the instrument's exterior should be accomplished immediately after unpacking it from its shipping container. If obvious damage is evident, both the shipping agency and Doric Scientific should be notified as soon as possible.

If the instrument shows no sign of damage, a quick electrical test can then be performed to insure that it is operative. By shorting the TC + and TC - terminals on the rear panel together and applying power to the instrument, the readout should display the approximate ambient temperature. If the readout displays the approximate figure, it may then be hooked up to the user's application.

NOTE: The thermocouple input must either be shorted or attached to a thermocouple. An open input will cause the break detect circuit to activate, which will result in the readout blurring.

2.2 REPACKING; RETURNING THE INSTRUMENT

If it is at all feasible, the original shipping container should be retained in the event reshipment of the instrument becomes necessary.

If the DS300 must be returned at any time to Doric for repair, modification, etc., insure that it is properly cushioned and packed and that a list of symptoms or work to be accomplished accompanies the instrument.

(Return the unit prepaid. Doric will, in turn, pay the freight charges when returning the unit to you.)

2.3 INSTRUMENT HOOKUP

2.3.1 Grounding Considerations

For noise-free operation, the measuring circuit should be connected to earth ground at one and only one point:

a. If the thermocouple is grounded, the circuit shown in Figure 2-1 should be employed.

b. If the thermocouple is completely floating, the circuit shown in Figure 2-2 will be most advantageous.

c. If the thermocouple is routed to an external reference junction, the circuit shown in Figure 2-3 must be used.

2.3.2 Wiring: Multipoint T/C Selector

As explained in Section I, the multipoint selector is a switching unit having the capability of accepting the outputs of several thermocouples; selecting one or more of them and feeding the signals into the thermocouple indicator.

The front panel of the selector consists of a series of pushbutton switches (12 to a row) which select the desired thermocouple.

To wire the multipoint selector, use the applicable procedure noted below:

a. Internal 12 Points

1. Remove the 2 screws securing the lower rear panel; remove the 2 screws from the bottom of the instrument and slide the circuit board out, noting how the black nylon guides are placed in the metal extrusion.

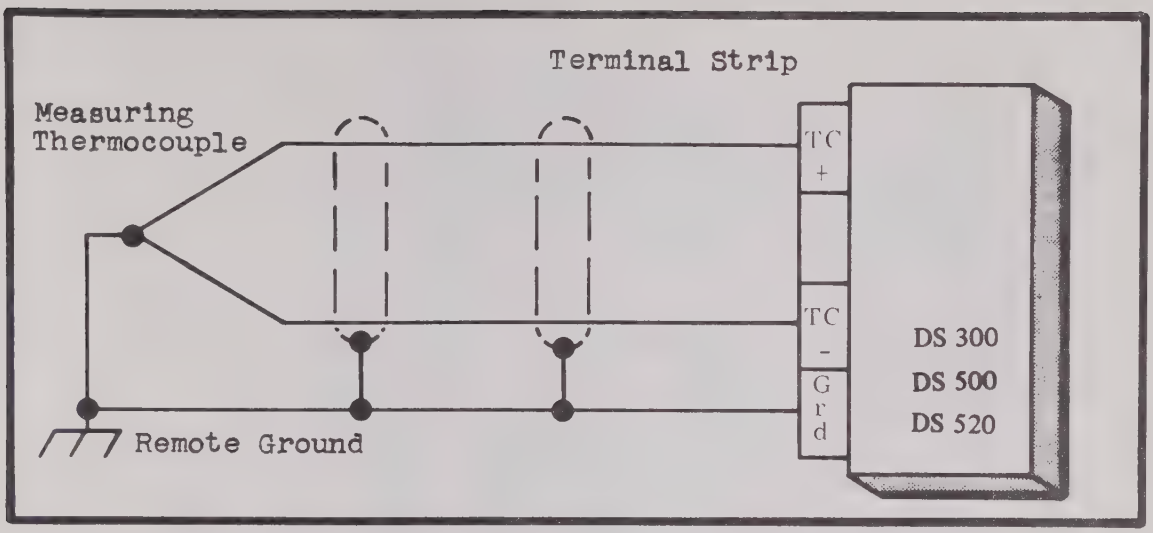


FIG. 2-1 GROUNDED THERMOCOUPLE

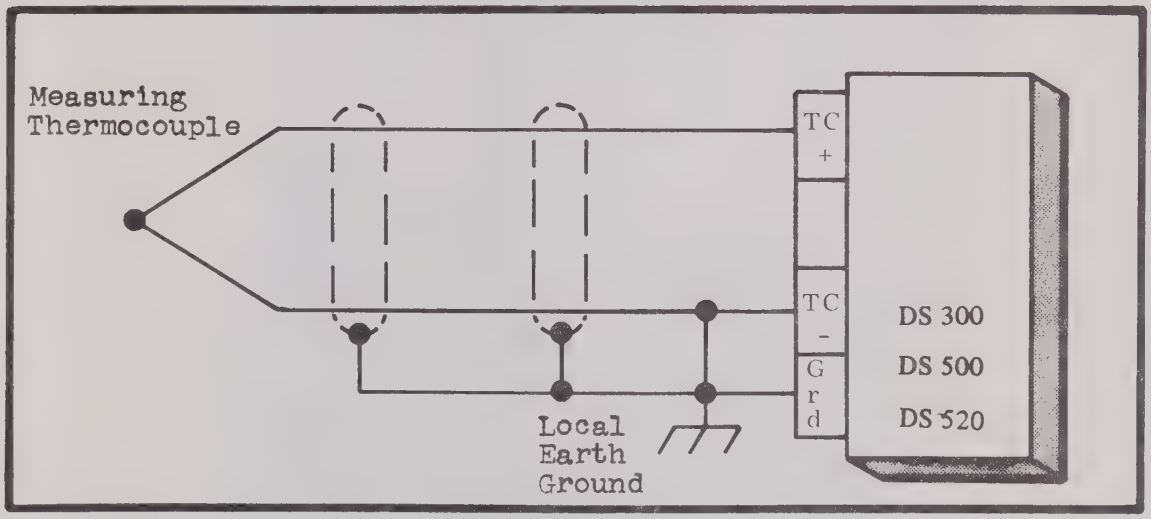


FIG. 2-2 FLOATING THERMOCOUPLE

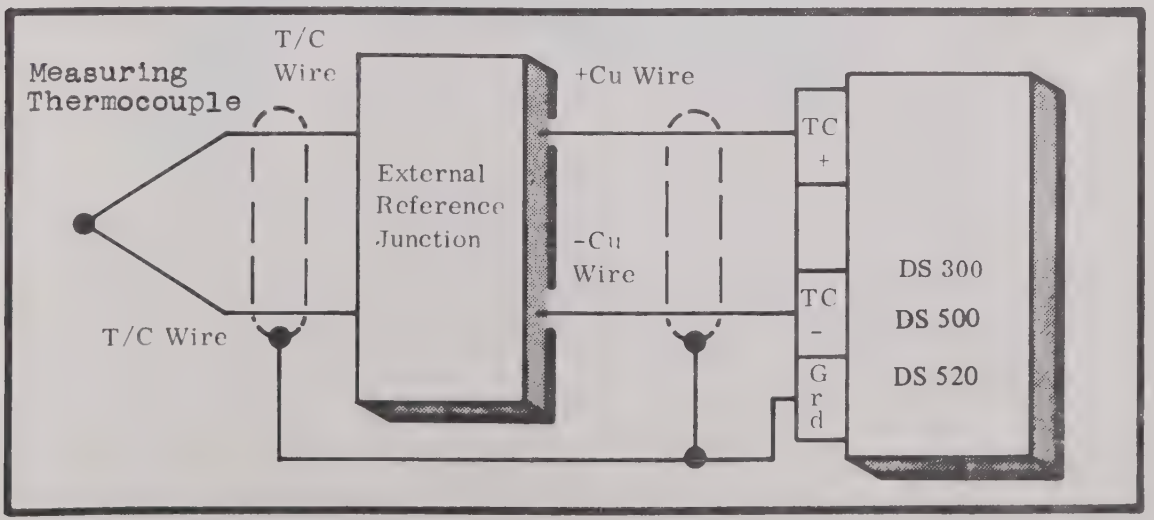


FIG. 2-3 EXTERNAL REFERENCE JUNCTION

2. Using Figure 2-4 as a guide, route the thermocouple wires to the appropriate terminals. (HI = TC +; LO = TC –) Switch numbers etched on board correspond to front panel switches as viewed from left to right when facing the unit. (S1 = the first front panel switch, etc.)
3. Run thermocouple wire from the HI, LO & GUARD terminals on the board. These 3 wires attach to the thermocouple inputs of the DS300-T3.

b. External 12 or 24 Points

1. Remove the 4 screws securing the rear panel; remove the 2 F.H. screws from the top and bottom of the instrument and slide the circuit board out, noting how the black nylon guides are placed in the metal extrusion.
2. Remove the shield by removing the 6 screws securing it to the board.
3. Using Figure 2-4 as a guide, route the thermocouple wires to the appropriate terminals. (HI = TC +; LO = TC –) Switch numbers on the bottom board correspond to front panel switches viewed left to right. (S1 = the first pushbutton on the left.) Because the second board is mounted upside down, S12 corresponds to the first switch on the left, S11 to the second, etc.
4. Run thermocouple wire from the HI, LO & GD terminals on the board. These 3 wires attach to the thermocouple inputs of the DS300-T3.
5. Replace the shield; slide the boards back into the housing.

2.3.3 Remote Programming/BCD Outputs

To give the instrument a remote sample command, two things must be accomplished. First, the Hold Line (pin 20) must be tied to the +5V line (pin 16). Then the positive-going edge of approximately 4V amplitude, 1 microsecond minimum rise time, 50 microseconds minimum duration, must be applied to pin 21.

The BCD outputs come from a series of hex inverters and have an output swing of 0-5 volts. Outputs are noted in the pin chart.

Outputs are positive true logic and have a maximum output impedance of 2K.

The sample complete pulse goes to a positive 5 volts at the end of an encoding. (Rise time of the pulse is totally dependent upon what kind of a load is present.) The pulse will remain positive until the beginning of a new encoding at which time it will drop to zero. Maximum output impedance is also 2K.

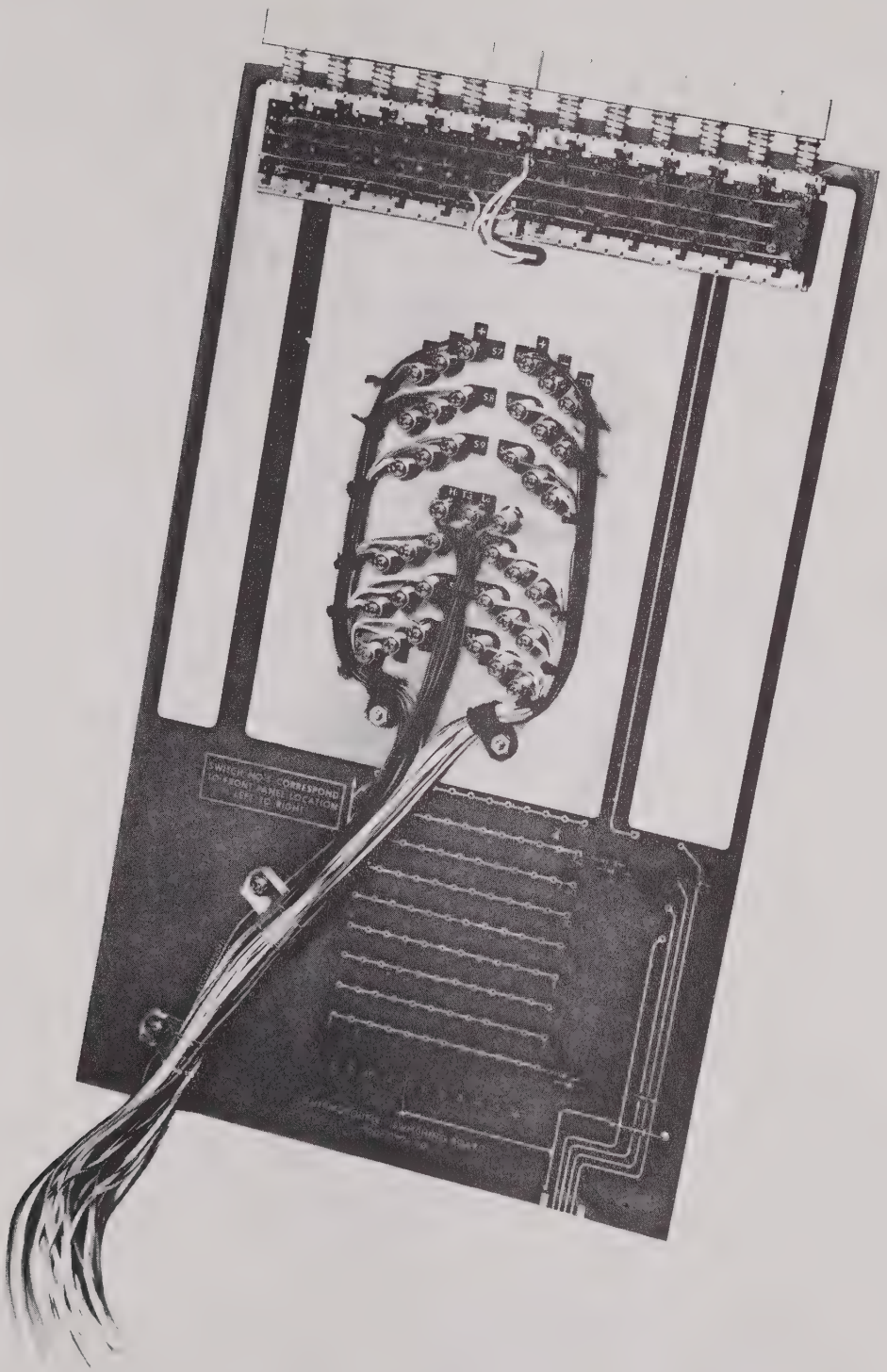


FIG. 2-4 MULTIPOINT WIRING

Amphenol Connector #57-30360
Reference Designator: J1

Pin	Function	Pin	Function
7	Do Not Use	11	Overload
17	N. O.	29	Do Not Use
18	Blank	31	Do Not Use
19	Blank	32	Do Not Use
14	Dec	33	Analog Output Hi
13	Sample Complete	20	Hold
34	Analog Output Common	21	Sample Command
22	2_3	4	4_1
2	1_1	28	8_0
3	2_1	30	4_0
6	1_3	1	8_1
26	4_2	10	Overflow 1
24	8_2	12	— Polarity
25	1_2	5	8_3
8	2_0	23	4_3
27	1_0	9	2_2
35	Blank	15	Digital Ground
36	Blank	16	+5V

FIG. 2-5 PIN CHART I/O CONNECTOR

2.3.4 Analog Outputs (DS300 only)

When requested, a low impedance (100Ω) analog output is supplied by means of a connector, J1, at the rear of the instrument. Because analog output LO is at the same potential as the DS300 LO input, it is mandatory that these outputs be used with floating, differential recorders (or other output devices). The connection should be made with a two-wire plus shield coax, with the shield connected to the guard pin and at the recorder end if the recorder is guarded. If the recorder is not guarded, the shield should be connected only at the guard pin.

Analog outputs are directly proportional to the millivolt input, being amplified 100 times ±1%. The 1% tolerance is inconsequential as the Gain Adjust on the recording device is more than adequate to compensate for this.

At ambient (23°C ±4°C), the output of the analog amplifier will typically display ±1 mv of zero offset. This also is of no consequence as this error is easily removed with the offset pot on the recording device.

2.3.5 T/C Indicator Used With DS305 Digital Control Unit

The Model DS305 is a digital processor for use with thermocouple indicators and is fully described in its own manual. The reason for this paragraph is to insure the user's knowledge that, if this option is ordered, a special design and rear panel are incorporated which means the two units must be interfaced with a supplied cable if the thermocouple indicator is to work at all.

A bypass connector is available from Doric which, when plugged into the Special DS305 connector on the rear panel of the T/C indicator, will allow the indicator to work without the DS305. This connector may be assembled in the field as noted:

Amphenol 57-30240 Connector —

1. Jumper pin 5 to pin 11.
2. Jumper pin 7 to pin 19.
3. Jumper pin 2 to pin 15.
4. Jumper pin 1 to pin 24.

ADDENDUM: Using The T/C Indicator In A System

A typical closed loop system is shown in Figure A. A print complete pulse causes the scanner to select a new channel. A remote encode command causes the DS300 to accept the signal input from the new channel and an encoding begins. A sample complete pulse (print command) is taken from J1 of the DS300 and fed to the printer where it is displayed in printed form and the entire procedure is then repeated.

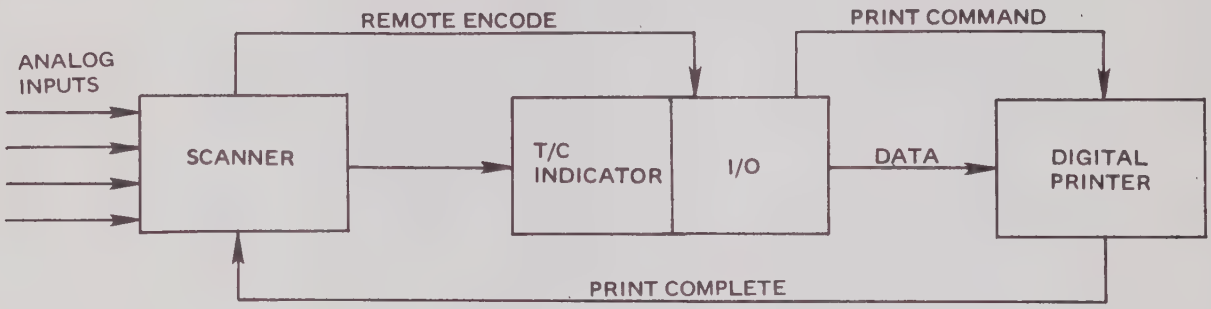


FIG. A TYPICAL SYSTEM INTERFACE

One problem exists when the DS300 is used in a scanning application. During the initial encoding of a channel's analog signal, the DS300's input filter is settling. This unavoidably introduces an error in the output. (If two or more readings are to be taken from a channel prior to switching, the second and subsequent readings will be correct as the input filters will have settled. However, when the scanner switches channels, the first encoding of the new input will again be in error.)

To eliminate this error, an external time delay must be introduced. This is accomplished by breaking the remote encode line and wiring in a delay of 350 MS. (Figure B)

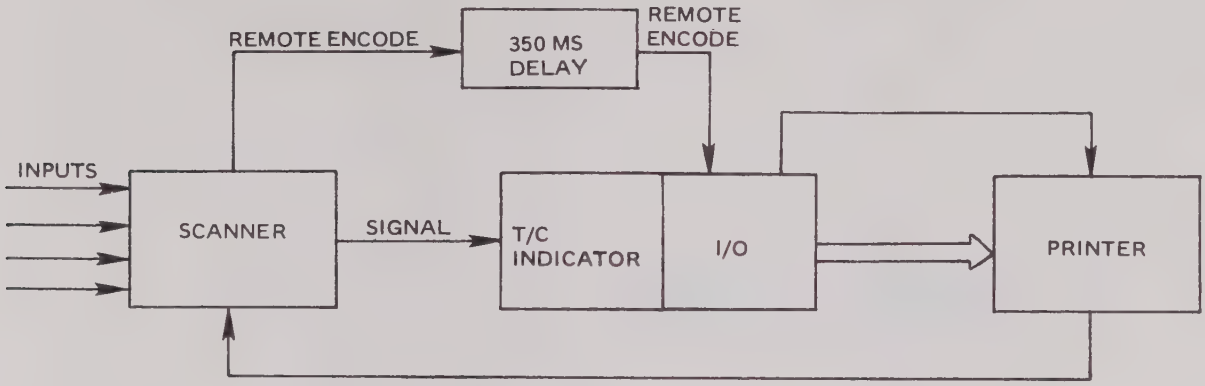


FIG. B SYSTEM INTERFACE WITH ADDED DELAY

The result of this, of course, is that the encode command will be delayed until the filter has completely settled, insuring accurate readings on the first encoding.

section 3

theory of operation

3.1 INTRODUCTION

The DS300-T3 thermocouple thermometer accepts thermocouple outputs in the form of low level DC voltages and measures them by using a dual slope integration method which is enhanced by Doric's AUTO-ZERO (Patent Pending).

During encoding of a voltage signal, the analog input of the meter is connected to the DC signal voltage for 100 ms (see Figure 3-1). During this fixed time (t_1), the integrating capacitor C10 charges at a rate proportional to the DC signal voltage (E_x). At the end of this fixed integration time, the input of the DS300-T3 is automatically disconnected from the signal source and connected to a precision reference voltage with a polarity opposing that of the DC input. This causes the integrating capacitor to discharge towards ground at a fixed rate. The discharge time (t_2) required to reach ground is proportional both to the

reference voltage and to the voltage peak (E_p) reached by the capacitor during the fixed integration time (t_1).

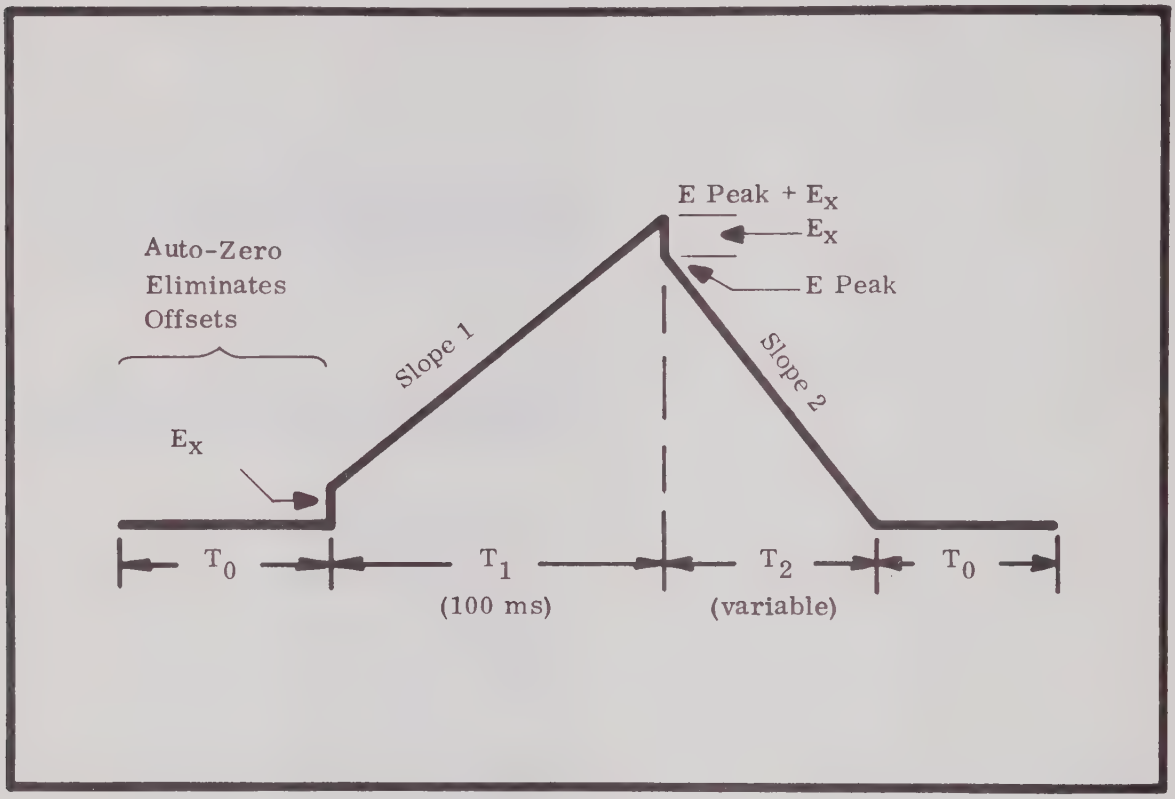


FIG. 3-1 DUAL SLOPE TECHNIQUE

Figure 3-2 shows that t_2 time is directly proportional to E_x and independent of variable factors such as the RC constant, clock frequency, amplifier gains and offsets.

To display E_x digitally, a constant 10 kHz is fed into the display counter during t_1 time. During t_2 time, a series of selected, varying frequencies is fed to the counter for a time proportional to the thermocouple voltage. Because of the varying frequencies, the counts are accumulated non-linearly, thus compensating for the non-linearity of the thermocouple output.

For every N counts into the display counter, a count is sent to the segment counter. The segment counter causes a set of frequencies to be selected via the digital programmer. The segment counter and digital programmer cause the frequency generator to put out a new frequency for each segment up until the time proportional E_x is reached. The number in the display counter is then displayed.

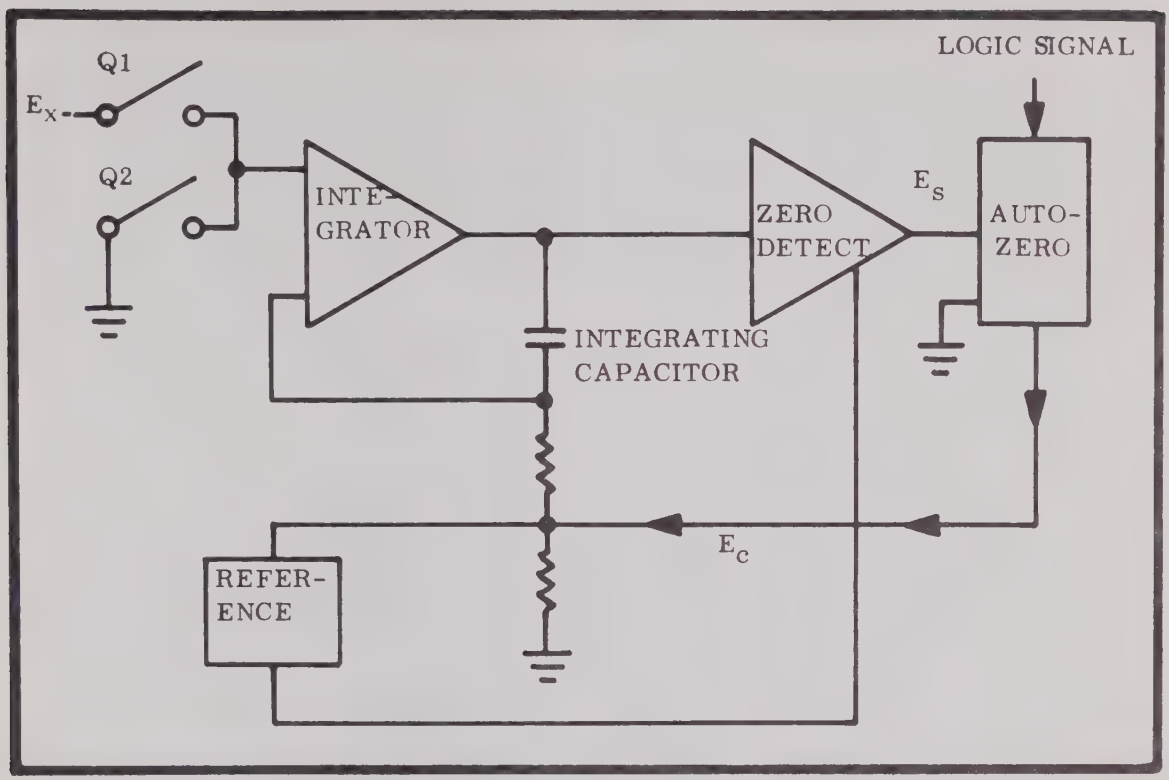


FIG. 3-2 ANALOG CIRCUITS SHOWING AUTO-ZERO

3.2 AUTO-ZERO (Patent Pending)

Between encodings, the instrument automatically disconnects itself from the signal source E_x and shorts its own input (see Figure 3-2). At this time, the AUTO-ZERO circuit measures the existing offset in the integrator amp and zero crossing amp. At the beginning of the next encoding, the AUTO-ZERO circuit stores the required voltage to cancel the sum of the offsets in these amplifiers.

Between encodings, the integrator amp's input is connected to ground. Note that the integrator and zero crossing amps are in series. Any offsets occurring in the integrator are amplified in the zero crossing amp and fed to the AUTO-ZERO. The amplified sum of all these offsets and slow drifts (E_s) is compared with reference to ground by the AUTO-ZERO which feeds back a correction voltage (E_c) to the integrator amp to force E_s to equal zero volts. As long as the operation continues, the output cannot drift off of zero.

3.3 MEASUREMENT CYCLE

When the measurement cycle starts, Q2 opens and Q1 closes, applying E_x to A1 (see Figure 3-2).

At the time that Q1 closes, a counter starts to count up from zero to 1,000 to provide the fixed time base, t_1. When the 1,000 is reached, Q1 is opened and either Q13 or Q15 is closed to either $+E_r$ or $-E_r$ as required to make the output of A1 slew towards ground. As Q13 and Q15 closes, the counter is reset to zero and again counts up from zero. When the charge on C10 is reduced to zero volts, the counting is stopped and the number accumulated in the counter is displayed on the readout.

3.4 CIRCUIT DESCRIPTION

3.4.1 Reference Junction

The reference junction used in the DS300-T3 is an epoxy encapsulated cold junction compensator providing the equivalent of an ice bath temperature of 32° F. It contains a self-compensating voltage generator network as shown in Figure 3-3. As the ambient temperature surrounding TC2 and TC3 varies, a thermally generated voltage appears and produces an error in the output. However, an equal voltage of the opposite polarity is automatically introduced; the series generator cancelling out the thermal error and maintaining the correct TC1 output over a wide ambient temperature range.

The reference junction provides the interface between the thermocouple wires and the instrument's inputs without the introduction of any secondary thermocouple errors.

Power to the reference junction is derived from the +6.2V Zener and -15 volt supply.

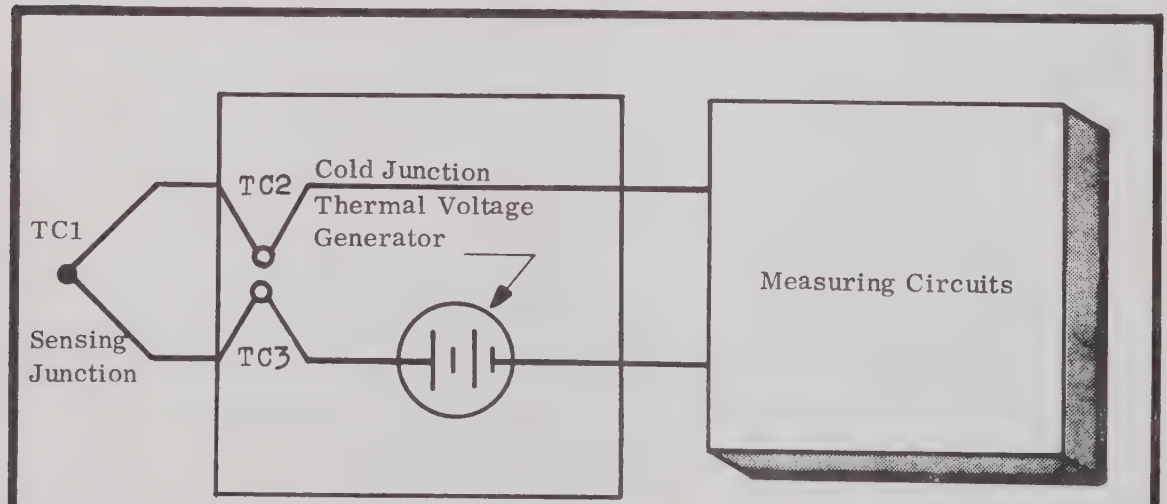


FIG. 3-3 REFERENCE JUNCTION

3.4.2 Offset Pot

The offset pot, R69, provides a precise voltage which is inserted in series with the reference junction output. The purpose of the pot is to provide a readout equal in degrees to the simulated reference junction temperature when the reference junction output is at zero volts.

3.4.3 Input Filter

The filter/limiter circuitry consists of a three pole active filter with an overload protection limiter attached to the filter output. This limiter (DS1) prevents high voltage from damaging the input stage by limiting the input to ±50 volts.

3.4.4 Analog Switching

There are six analog switching channels in the DS300; all essentially the same. Each channel is formed by a high-level driver and junction FET switch. The drivers convert I.C. logic levels to high voltage swings; then the FET switches convert these voltage swings to solid-state "closures." When the driver is turned off, the FET gate becomes zero biased with respect to the source causing a low impedance to appear between drain and source. When the driver is turned on, the gate is pulled negative which causes several thousand megohms to appear between drain and source.

3.4.5 Sample Rate Generator

The sample rate generator is an integrator that commands the L_1 flip-flop to start each new encoding. The SRG is controlled by L_0. As L_0 goes low, it allows Q21 to integrate positive at a rate of 10v/sec. This ramp is coupled with the clock sync and fed to the emitter of Q22. The base of Q22 is biased by Z24(5) at +2.5v. As the emitter of Q22 approaches +3 volts, a positive going clock pulse will trigger Q22 on, causing Q23 to turn on, clamping the input of Z24 to GND. The inverted state of Z24 will set L_1 positive and start a new encoding. The positive level of L_1 will set L_0 positive which, in turn, drives Q21 to its low state and clamps the ramp to GND.

3.4.6 Integrating Amplifier

The integrating amplifier is a high-input impedance, high gain operational amplifier. Its first stage is a dual FET amplifier which has a very high input impedance and very low current offset. The amplifier has a typical gain of 10. Its output drives the input of an operational amplifier with a typical open loop gain of 80,000. Capacitor C10 supplies negative feedback to the summing junction and R26 and R38 set the full scale current.

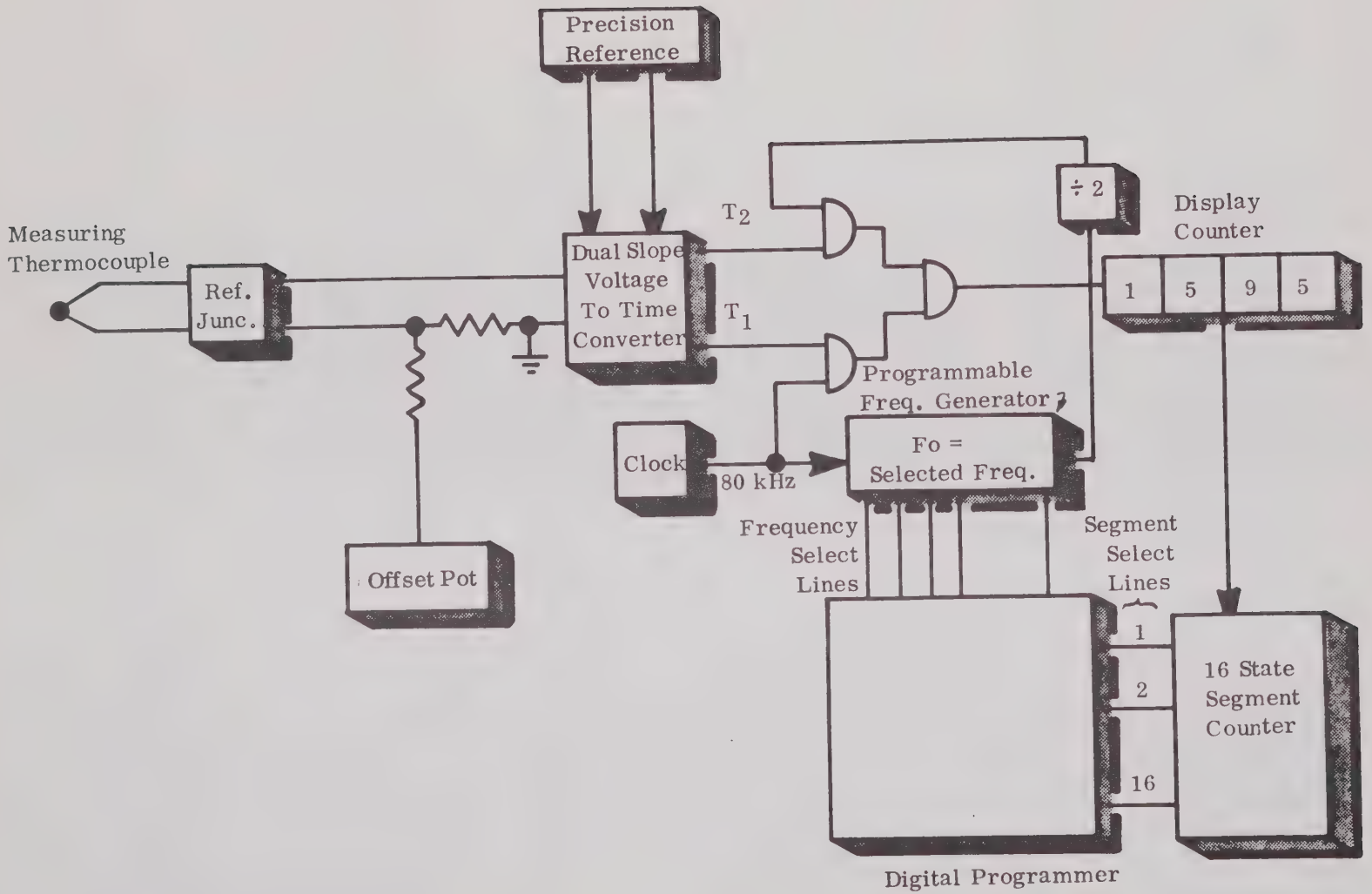


FIG. 3-4 BLOCK DIAGRAM

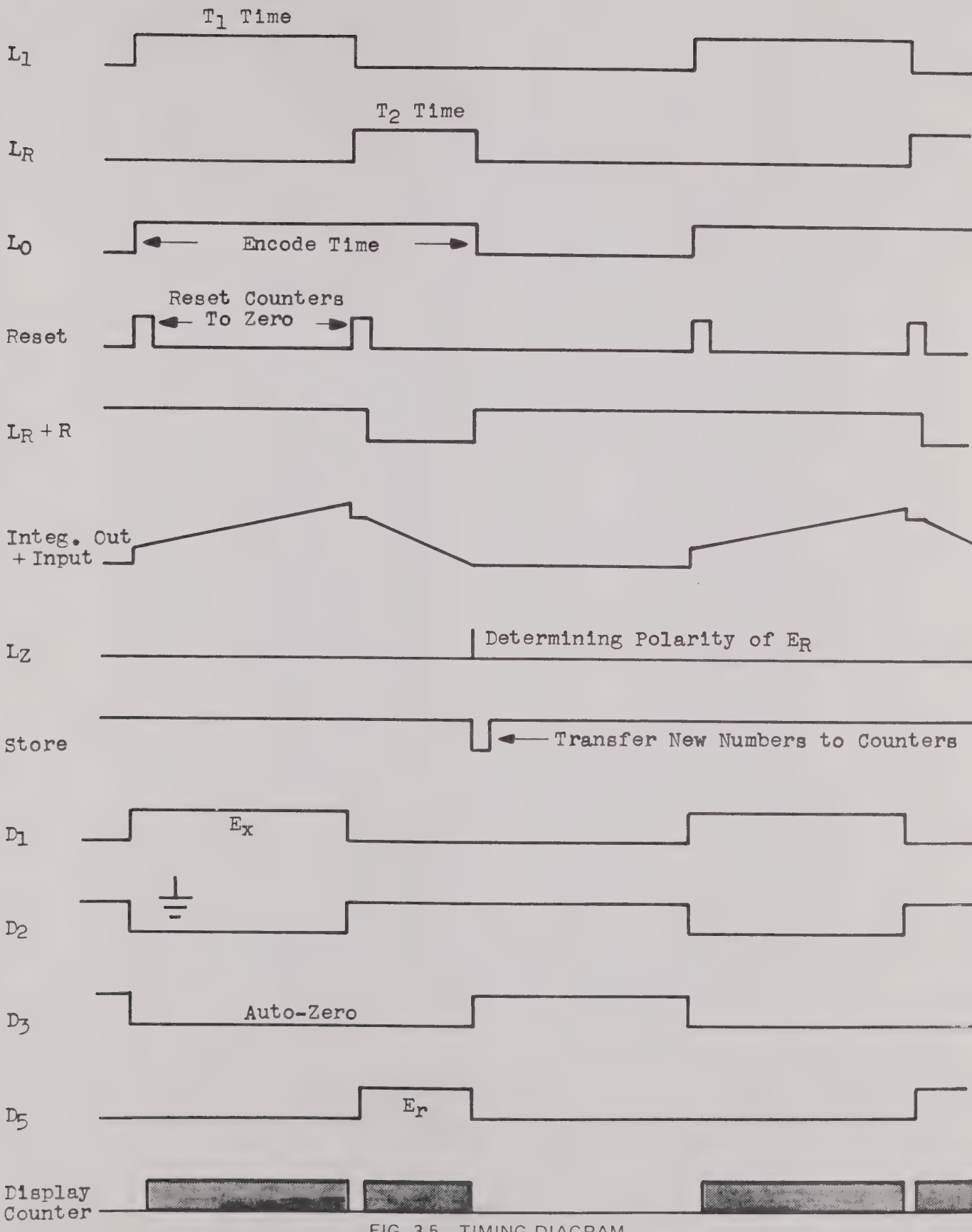


FIG. 3-5 TIMING DIAGRAM

3.4.7 Zero Crossing Amplifier

The zero crossing amplifier is a two-stage, wideband DC amplifier which detects the zero crossings of the integrator amplifier. R24 is a current limiter which prevents overload to the integrating amplifier or damage to Q9. Typical open loop gain is 50,000.

3.4.8 Zero Schmitt Trigger/Dual Differentiator

The zero Schmitt trigger squares up the amplified zero crossing to provide a logic level transition at the exact moment the integrator crosses zero. It is formed by Z14. Z14 outputs (pins 10 and 13) are fed into dynamic AND gates and are differentiated. Resulting waveforms are fed to pin 6 of Z15. Consequently, a negative pulse from either Z14, pin 10 or 13, becomes a positive pulse at Z15, pin 4, resetting the reference flip-flop L_R.

3.4.9 Auto-Zero Circuit

The auto-zero circuit consists of a sample and hold circuit. R30 and R31 translate the zero crossing amplifier output voltage to the input of Q11. Q11 couples this voltage to the storage capacitor, C13. Q12 is a high input impedance source follower which supplies the correction voltage E_c to integrator. When an encoding starts, Q11 is turned off, and the last voltage required to zero the system is stored on C13, assuring a continuous correction voltage is applied to the input integrator.

3.4.10 Reset Mono

The reset mono is formed by two dynamic AND gates and a gate inverter followed by two flip-flops. A positive going edge into either of the dynamic AND gates will cause Z14(4) to reset Z30(5) which, in turn, resets Z30(3). 50μsec later the negative edge of the 20 kHz signal will toggle Z30(5) to its positive state removing the reset on Z30. 12μsec later the negative edge of the 80 kHz clock will toggle Z30 removing the final reset function.

3.4.11 Clock

The clock consists of a single transistor Q20 with transformer coupled positive feedback. The clock frequency is set at 80 kHz. Z24, pin 10 gate acts as a clock buffer.

3.4.12 Programmable Frequency Generator

(In order to linearize a non-linear thermocouple output, some part of the A to D converter must be made non-linear, but in a highly precise and reproducible way. To accomplish this, two things are needed: a digitally programmable frequency generator and a digital programmer.)

The frequency generator employed in the DS300 derives its primary frequency from an 80 kHz oscillator. This frequency is, in turn, divided down by a string of J-K flip-flops (Z31 - Z34). These develop octave related frequencies, some of which are summed together under the control of Z35. The summed frequencies are then fed to the A to D converter via Z34, Z37, and Z29(4). During t_1 time, the clock, being controlled by Z29(1), bypasses the summer and is fed directly to the A to D converter.

3.4.13 Digital Programmer

The programmer periodically changes the frequency going to the A to D converter during t_2 time. The programmer implements the changes by picking off a frequency from the display counter and feeding it through appropriate control gates to a binary up counter (Z36), which, in turn, controls a 128-bit read only memory (Z35). Each of the 16 states of the binary up counter selects a set of frequencies. When any one of the 16 states is programmed, its related binary word controls the frequencies to the summer. When the binary up counter steps from 1 through 8, eight separate sets of frequencies are selected. When a second curve (8 segments) is required, steps 9 through 16 are used.

3.4.14 Display Counter

Dependent upon full-scale requirements, the display counter consists of three or four identical decades. Each decade is made up of an 8-4-2-1 BCD counter, a gated latch storage unit and a BCD to decimal decoder-driver. The counter accepts pulses from Z29(10) and divides the frequency by 10. Output from the 8-bit is fed to the next decade. All four bits are fed to the storage unit. When the hold input goes low at the end of an encoding, the four bits in the counter are transferred into the flip-flops of the storage unit. When the hold input is returned high, the storage unit ignores any changes in the state of the counter. Outputs of the storage unit are connected to the decoder-driver inputs. The decoder-driver contains internal logic which converts the binary information into one-out-of-ten information. Output is in the form of 10 high voltage driver lines which are connected to the ten cathodes of a nixie tube.

3.4.15 Polarity Detection

Information for polarity determination is available on the L_Z and $\overline{L_Z}$ lines at the beginning of L_R. This information provides the enable inputs for L_p flip-flop. The leading edge of $\overline{L_R}$ causes the polarity information to be set into L_p. If Z37, pin 2, is high, the minus sign will be turned on. A positive polarity is not displayed.

3.4.16 Overflow One

Principle of operation for the "overflow one" storage flip-flop (Z27) is the same as described in polarity detection. Pins 5 and 6 of Z27b are applied to the enable inputs of Z27a. The leading edge of the store pulse causes the information to be transferred from Z27b to Z27a flip-flop. High voltage driver Q24 displays the information through the "1" neon.

3.4.17 Overload Detection

The overload detection circuitry consists of four gates from Z28 and transistors Q27 and Q26. Pins 10 and 13 of Z28 form an R-S flip-flop which controls the on-off state of Q27. Pin 1 of Z28 acts as an inverter. Pin 3 of Z28 is connected (by a selection feedthrough) to either Z16 or Z21 decade counter for a known overload frequency count. L_1 inhibits Z28, pin 4 output during t_1 time. During t_2 time, L_1 is low, while the selected decade count line will remain high until the selected overload count is reached. When this occurs, the decade count line will go low, causing Z28, pin 4, to set the flip-flop. When Z28, pin 13, goes low, Q26 will turn off, releasing the VCC power supply connection for the nixie decoders and the emitter of Q16. The nixies will then blur until the start of the next encoding, indicating an overload condition. When the next encoding begins, the reset pulse will reset the flip-flop turning Q26 back on. This sequence will repeat itself so long as an overload condition exists.

section 4

calibration & maintenance

4.1 TEST EQUIPMENT NEEDED

A DC calibrator capable of supplying accurate voltages up to 100 mv with better than 1 microvolt resolution and stability is required. A stable ice bath, accurate to 0.5° is also needed.

4.2 CALIBRATION PROCEDURE

(For Instruments Having Internal Reference Junction)

a. Allow the instrument a 30-minute warm-up period.

b. Hook the DC calibrator and ice bath to the DS300 as shown in Figure 4-1.

c. Prepare test wires as shown in Figure 4-3.

d. Refer to Figure 4-4 and follow the calibration instructions noted.

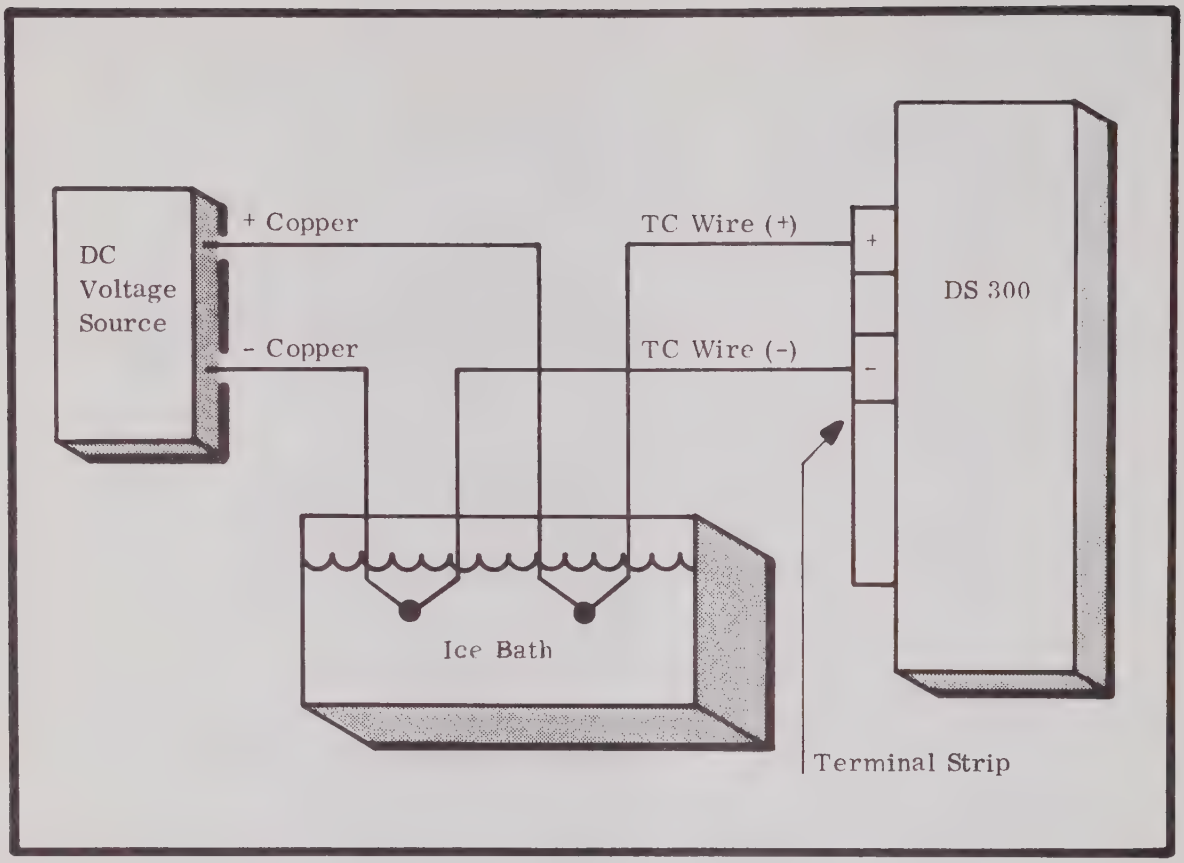


FIG. 4-1 TEST/CALIBRATION SET-UP (Internal Reference Junction)

NOTE: To gain access to calibration controls as shown in Figure 4-2, remove the two screws from the center of the rear panel. This will make the inner portion of the DS300-T3 mobile. The inner portion may then be pushed forward, with the power cable and test wires attached, until the three pots are accessible.

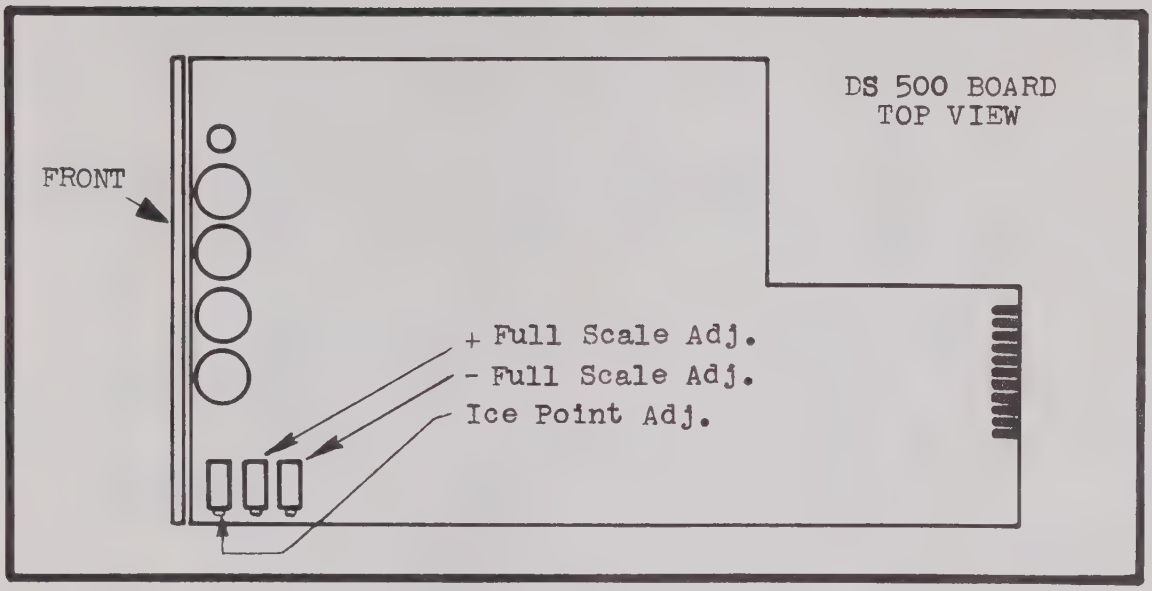


FIG. 4-2 CALIBRATION CONTROLS

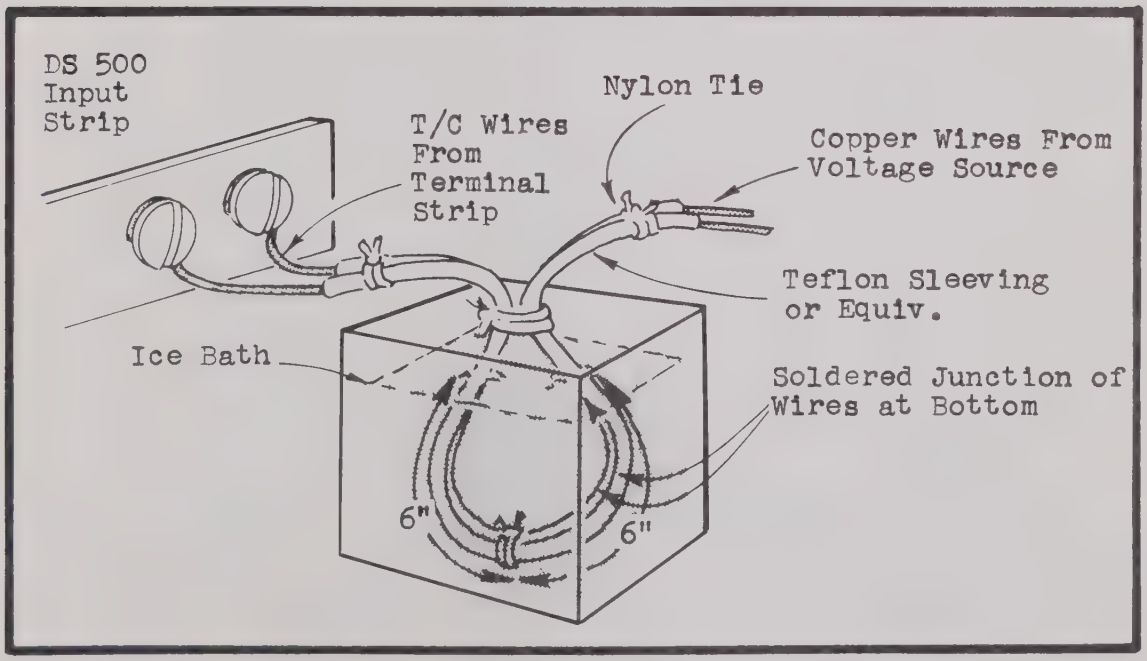


FIG. 4-3 PREPARING WIRES FOR AN ICE BATH

*T/C Type	Materials	Range	Input	Adjust	Read	Input	Adjust	Read	Input	Adjust	Read
K	Chromel-Alumel	0 to 2400°F	0.000 mv	32° Offset Pot	+32° F	52.939 mv	+Ref Pot	2400°F	—	—	—
J	Iron-Constantan	0 to 1595°F	0.000 mv	32° Offset Pot	+32° F	50.059 mv	+Ref Pot	1595°F	—	—	—
T	Copper-Constantan	-310 to +750°F	0.000 mv	32° Offset Pot	+32° F	20.805 mv	+Ref Pot	750°F	-5.439 mv	-Ref Pot	-310°F
T	Copper-Constantan	-60 to +400°C	0.000 mv	32° Offset Pot	0° C	20.869 mv	+Ref Pot	400°C	-2.152 mv	-Ref Pot	-60°C
E	Chromel-Constantan	0 to 1600°C	0.000 mv	32° Offset Pot	+32° F	66.559 mv	+Ref Pot	1600°C	—	—	—
R	Plat-Plat-Rhodium 13%	800 to 1600°C	0.000 mv	32° Offset Pot	0°C	18.842 mv	+Ref Pot	1600°C	—	—	—
S	Plat-Plat Rhodium 10%	800 to 1600°C	0.000 mv	32° Offset Pot	0°C	16.771 mv	+Ref Pot	1600°C	—	—	—

*Standard Ranges. For other ranges, refer to NBS V to T Charts.

EXAMPLE: For Type K: Apply compensated calibrator (Figure 4-1) to + and - T/C inputs on the DS300-T3. Apply 0.000 mv and adjust the 32° Ref Pot for a readout of +32° F. Apply 53.0100 mv to the DS300-T3 T/C input. Adjust the +Ref Pot for a readout of 2400° F.

FIG. 4-4 CALIBRATION CHART FOR INSTRUMENTS HAVING INTERNAL REFERENCE JUNCTIONS

4.3 CALIBRATION PROCEDURE

(For Instruments Having External Reference Junctions)

To calibrate an instrument having an external 32° or 150° reference junction, hook up equipment as shown in Figure 4-5 and follow the chart in Figure 4-6.

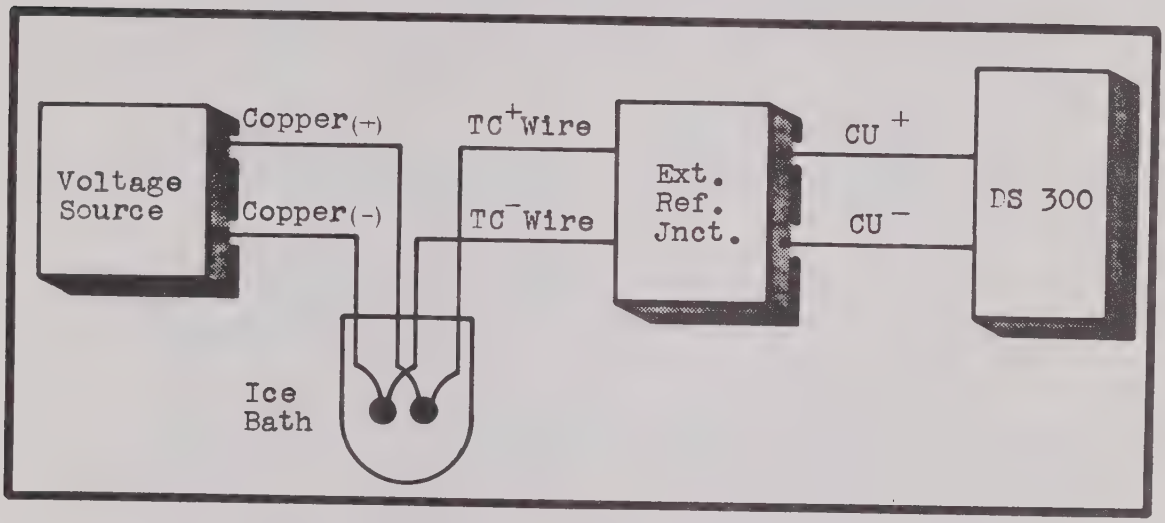


FIG. 4-5 EXTERNAL REFERENCE JUNCTION CALIBRATION

T/C Type	Input	Adjust	Read	Input	Adjust	Read	Input	Adjust	Read
K	0.000 mv	Offset Pot	32° or 150°	53.0100 mv (32°) 50.3500 (150°)	+Ref Pot	2400°F			
J	0.000 mv	Offset Pot	32° or 150°	50.7600 mv (32°) 47.3500 (150°)	+Ref Pot	1595°F			
T	0.000 mv	Offset Pot	32° or 150°	21.4750 mv (32°) 18.7640 (150°)	+Ref Pot	750°F	-4.7090 mv (32°) -7.4200 (150°)	-Ref Pot	-310°F
E	0.000 mv	Offset Pot	32° or 150°	67.6500 mv (32°) 63.6100 (150°)	+Ref Pot	1600°F			

FIG. 4-6 CALIBRATION CHART FOR INSTRUMENTS HAVING EXTERNAL REFERENCE JUNCTIONS

4.4 TROUBLESHOOTING

4.4.1 Introduction

It is unlikely that your Doric instrument will need any repairs during its lifetime. In case the situation does arise, a novel program of trouble analysis has been worked out which is both effective and easy to follow. After the program will be found voltage charts and hold condition checkout chart.

4.4.2 Notes on Circuit Analysis

Once a fault has been isolated to a given circuit, the following steps should be taken before replacing components:

a. Check the theory of operation, Section III, and circuit description section given in fault isolation program. This will tell what the circuit is supposed to do and how it should operate.

b. Analyze the input waveform for proper voltage levels and rise or fall times.

c. Check for abnormal loads on circuit in question. The schematic will help in finding what the normal load is.

d. Trace signal path in the circuit, component by component, with an ohmmeter to ensure that there are no abnormal opens or shorts.

e. Replace bad components as required.

4.4.3 Troubleshooting Programs

The following pages contain the programs, which, when worked through systematically, will locate a malfunction in any part of the instrument. Each initial item in each sequence contains a question, the answer to which is a simple yes or no. Each answer leads to the next step or path in the program, logically eliminating each possibility until the trouble is located.

FAULT ISOLATION PROCEDURE

STEP NO.	PROCEDURE	IF YES GO TO NUMBER	IF NO GO TO NUMBER
1	Are all power supplies OK per Figure 4-7?	7	2
2	Are all loads normal per Figure 4-7?	3	6
3	Are fuses OK?	5	4
4	Replace fuses. Return to Step 1.	—	—
5	Analyze bad power supply; correct fault and return to Step 1.	—	—
6	Analyze incorrect load; correct fault; return to Step 1.	—	—
7	Set meter in Auto-Zero mode. Apply +4V to R88 hold line and check if circuit condition agrees with Figure 4-8.	8	Go to step shown in Chart 4-8
8	Apply a voltage source to the input. Go to Step 9.	—	—
9	Does L_0 oscillate?	10	29
10	Does $\overline{L_1}$ positive-going transition fire $\overline{L_R}$?	11	26
11	Does $\overline{L_R}$ fire $\overline{L_R}$ + R?	12	26
12	Does $\overline{L_R}$ + R turn on Q15 or Q18?	13	72
13	Is E_C polarity the same as integrator output?	14	72
14	When integrator amp slews toward –.5V, does it cause L_Z and $\overline{L_Z}$ to change state?	15	72
15	When L_Z and $\overline{L_Z}$ change states, does it reset L_R via dual differentiator?	16	93
16	Does the positive transition of $\overline{L_R}$ cut off clock pulses?	17	26
17	Does negative L_R transition fire L_0?	18	26
18	Does L_0 pulse transfer counter information into the storage registers?	19	26
19	End of encoding sequence.		

FAULT ISOLATION PROCEDURE (Continued)

STEP NO.	PROCEDURE	IF YES GO TO	IF NO GO TO
20-25	Unassigned.		
26	Are waveforms from previous circuit OK?	27	28
27	Check operation of circuit in question using circuit description; correct fault and return to the step taken prior to Step 26.	—	—
28	Check operation of previous circuit using circuit description; correct fault and proceed along "Yes" route.	—	—
29	Does input to Z19 pin 2 oscillate?	30	46
30	Is L_0 true?	31	39
31	Is Q21 collector false?	32	38
32	Is $\overline{L_1}$ true and L_1 false?	33	38
33	Is Z19 pin 10 true?	34	36
34	Is L_0 now false?	9	38
35	Change Z19 and go to Step 33.	—	—
36	Force L_R to be false; is Z19 pin 10 true?	37	35
37	Repair L_R circuit and return to Step 33.	—	—
38	Analyze circuit, correct fault, and return to previous step.	—	—
39	Is Q21 collector true?	40	38
40	Is flip-flop $\overline{L_1}$ false and L_1 true?	41	38
41	Is Z19 pin 10 false?	42	38
42	Is L_0 now true?	9	38
43-45	Unassigned.	—	—
46	Does 80 kHz clock oscillate?	47	38
47	Does J-K flip-flops Z31 to Z34 toggle?	48	38

FAULT ISOLATION PROCEDURE (Continued)

STEP NO.	PROCEDURE	IF YES GO TO NUMBER	IF NO GO TO NUMBER
48	Tie the junction between Z35 and R77-R85 to ground. Is the frequency at Z24, pin 8, 160 kHz? (Each circuit can be tested individually by grounding one resistor at a time; check for correct frequency.)	49	38
49	Does clock gate allow pulses to flow to counter?	50	55
50	Does 8-bit in 10^2 decade divide input frequency by 1000?	51	66
51	Does Z36, pin 14, toggle?	52	58
52	Does Z36, pin 1, toggle?	53	59
53	Unground R.O.M. (Z35) - R77 to R85 junction. Does Z24, pin 8, oscillate?	54	60
54	Does Z19, pin 2, now have signal?	29	61
55	Is L_1 in opposite state to L_R?	57	56
56	Analyze Z19, correct fault, and return to Step 49.	—	—
57	Analyze clock gate and amplifier circuits; correct fault and return to Step 49.	—	—
58	Analyze selection segment counter, correct fault and go to Step 51.	—	—
59	Analyze Z36, correct faults, and go to Step 52.	—	—
60	Replace Z35 or correct faults of matrix board and go to Step 53.	—	—
61	Trace signal from Z21, pin 1, through C22, to Z19; correct faults and return to Step 54.	—	—
62-64	Unassigned	—	—
65	Go back to Step 50.	—	—
66	Does 8-bit 10^0 decade divide input by 10?	67	69
67	Does 8-bit 10^1 decade dibide input by 100?	68	70
68	Does 8-bit 10^2 decade divide input by 1000?	65	71

FAULT ISOLATION PROCEDURE (Continued)

STEP NO.	PROCEDURE	IF YES GO TO NUMBER	IF NO GO TO NUMBER
69	Analyze 10^0 decade counter, correct fault, and return to Step 66.	—	—
70	Analyze 10^1 decade counter, correct fault, and return to Step 67.	—	—
71	Analyze 10^2 decade counter, correct fault, and return to Step 68.	—	—
72	Is integrator amplifier more positive than –.5V?	84	73
73	Is zero amplifier output appriximately –13V?	74	88
74	Is pin 13 of Z14 true?	75	89
75	Is L_R true?	76	11
76	Is L_Z in opposite state to pin 13 of Z14?	77	86
77	Is $\overline{L_Z}$ in opposite state to L_Z?	78	87
78	Does $\overline{L_R}$ + R go low when L_R fires?	79	26
79	Is L_Z false?	80	81
80	Is Q13 on?	13	83
81	Is Q15 on?	13	82
82	Analyze Q15 circuit, correct fault, and return to Step 13.	—	—
83	Analyze Q18 circuit, correct fault, and return to Step 13.	—	—
84	Is output of zero amplifier approximately 0V?	85	88
85	Is pin 13 of Z14 false?	75	89
86	Check Z14, correct faults, and return to Step 76.	—	—
87	Check Z14, correct faults, and return to Step 77.	—	—
88	Analyze zero amplifier, correct faults, and return to Step 73 or Step 84.	—	—

FAULT ISOLATION PROCEDURE (Continued)

STEP NO.	PROCEDURE	IF YES GO TO NUMBER	IF NO GO TO NUMBER
89	Analyze Z14, correct fault, and return to Step 74 or Step 85.	—	—
90-92	Unassigned	—	—
93	Is D4 oscillation reaching pin 13 of Z24?	94	96
94	Is there a negative differentiated pulse on pin 6 of Z15?	95	97
95	Does $\overline{L_R}$ go true?	16	98
96	Trace oscillation through feedthrough circuit straps, etc., correct fault, and return to Step 93.	—	—
97	Analyze dual differentiator, correct fault, and return to Step 94.	—	—
98	Analyze L_R – $\overline{L_R}$ flip-flop, correct fault, and return to Step 95.	—	—
99	Refer to Section III, Paragraph 3.4.5 for Theory of Operation. Go to Step 8.	—	—
100	Refer to Section III, Paragraph 3.4.4, Analog Switching. Go to Step 104.	—	—
101	Refer to Section III, Paragraph 3.4.6, Integrating Amplifier. Go to Step 106.	—	—
102	Refer to Section III, Paragraph 3.4.7, Zero Crossing Amplifier. Go to Step 107.	—	—
103	Refer to Section III, Paragraph 3.4.9, Auto-Zero Circuit. Analyze circuit and correct fault.	—	—
104	Are the inputs to the analog switches OK? ($\overline{L_1}$ – HIGH; L_1 – LOW; L_R – LOW; L_Z – LOW; $\overline{L_R}$ + R – HIGH)	105	8
105	Analyze circuit in question, correct fault, and return to Figure 4-8.	—	—
106	Is pin 6 of Q4 positive?	26	72
107	Is pin 6 of integrator amplifier –.60V ±2V?	26	72

Nominal Voltage	Actual Voltage	Load Resistance (Analog Section)	Load Resistance (Digital Section)
+8V D	8V ±2V	>10K	
+25V	+22 ±1.5V		>5K
+15V	+15 ±.75V		>5K
-15V	-15 ±.75V		>2K
+5V D	+5 ±.25V		>300Ω
+190V	+190V ±20V	>40K	

FIG. 4-7 NORMAL POWER SUPPLY VOLTAGES AND LOAD RESISTANCES

NOTE: Load resistances should be measured with the power off. All load resistances should be measured with respect to ground except +5V which is measured with respect to -15V. The ohmmeter terminal must have the same polarity as the power supply being measured. These measurements are to be made with an ohmmeter having a 1.5V voltage source.

Logic Level	Logic State or Voltage	Step. No.
S.R.G. (Q21)	0	99
L^1	0	8
L_0	0	8
L_R	0	8
L_Z	1	8
D_1 (Q16)	-15	100
D_2 (Q19)	0	100
D_3 (Q17)	+15	100
D_5 (Q18)	-15	100
D_6 (Q15)	0	100

Analog Test Pin	Voltage	Step No.
Q_4 FET Input	0V	100
Integrator Out	-.6V ±.2V	101
Zero Amp Out	-5V ±5V	102
Auto-Zero	0 ±5V	103

NOTE: The Auto-Zero condition is set by applying +5V to R62 or grounding Q21 collector. Disconnect this line after Auto-Zero test.

FIG. 4-8 AUTO-ZERO CONDITION CHECKOUT CHART

section 5

parts lists; schematics

DS 300

DESCRIPTION	QTY.	DORIC P/N	MFG & P/N		REC SPARES	UNIT PRICE
Integrated Circuit SN 74141	3	965-521-00		SN74141		3.50
Integrated Circuit SN 7475	3	965-517-00		SN7475		2.50
Integrated Circuit SN 7490	4	965-518-00		SN7490		2.75
Integrated Circuit SN 74107	7	965-520-00		SN74107		1.85
Integrated Circuit SN 7402	8	965-516-00		SN7402		1.00
Integrated Circuit SN 7493	1	965-519-00		SN7493		3.50
Hex Inverter MC840P	1	965-522-00		MC840P		2.65
Transistor 2N3415	1	962-341-50		2N3415		.80
Transistor 2N3393	7	962-339-30		2N3393	1	.60
Transistor 2N3877A	5	962-387-71		2N3877A	1	1.25
Transistor 2N4250	3	962-425-00		2N4250	1	.75
Transistor 2N3638	2	962-363-80	Fairchild	2N3638	1	.50
Transistor 2N5296	1	964-529-60	RCA	2N5296		2.95
Rectifier MCR4061	1	966-002-10				3.00
Regulator CMC5133	2	965-523-00				4.50
Field Effect Transistor 2061	1	100-729-00	Doric	100-729-00		1.25
Field Effect Transistor 1742	8	100-722-00	Doric	100-722-00	2	1.50
Dual FET SU2211	1	100-724-00	Doric	100-724-00		11.25
Op-Amp 741	1	965-506-00	Motorola	741	1	3.00
Diode 1N914	23	961-091-40	Continental Devices	1N914	5	.25
Diode 1N457	1	961-045-70		1N457		.55
Diode 1N702	1	961-070-20		1N702		2.00
Diode 1N751	1	961-075-10		1N751		1.00
Rectifier SCE2	4	966-002-00		SCE2	1	1.35
Rectifier SCE6	1	966-002-04		SCE6		3.00
Resistor 22 ohm ¼W	1	942-202-20	Allen Bradley			.15
Resistor 100 ohm ¼W	1	942-201-01	Allen Bradley			.15
Resistor 150 ohm ¼W	1	942-201-51	Allen Bradley			.15
Resistor 390 ohm ¼W	9	942-203-91	Allen Bradley			.15
Resistor 1K ¼W	7	942-201-02	Allen Bradley			.15
Resistor 1.5K ¼W	4	942-201-52	Allen Bradley			.15
Resistor 2.2K ¼W	2	942-202-22	Allen Bradley			.15
Resistor 6.2K ¼W	1	942-206-22	Allen Bradley			.15
Resistor 4.7K ¼W	11	942-204-72	Allen Bradley			.15
Resistor 10K ¼W	13	942-201-03	Allen Bradley			.15
Resistor 12K ¼W	1	942-201-23	Allen Bradley			.15
Resistor 15K ¼W	3	942-201-53	Allen Bradley			.15

DESCRIPTION	QTY.	DORIC P/N	MFG & P/N		REC SPARES	UNIT PRICE
Resistor 22K	13	942-202-23	Allen Bradley			.15
Resistor 39K	1	942-203-93	Allen Bradley			.15
Resistor 47K	1	942-204-73	Allen Bradley			.15
Resistor 68K	6	942-206-83	Allen Bradley			.15
Resistor 75K	1	942-207-53	Allen Bradley			.15
Resistor 100K	3	942-201-04	Allen Bradley			.15
Resistor 120K	2	942-201-24	Allen Bradley			.15
Resistor 150K	2	942-201-54	Allen Bradley			.15
Resistor 220K	1	942-202-24	Allen Bradley			.15
Resistor 470K	2	942-204-74	Allen Bradley			.15
Resistor 680K	1	942-206-84	Allen Bradley			.15
Resistor 1Meg	2	942-201-05	Allen Bradley			.15
Resistor 22K ½W	4	942-302-23	Allen Bradley			.20
Resistor 1% RN60C 2.21K	1	920-422-11	IRC			.50
Resistor 1% RN60C 1.78K	1	920-417-81	IRC			.50
Resistor 1% RN60D 511 ohm	1	920-351-10	IRC			.40
Resistor 1% RN60D 100 ohm	1	920-310-00	IRC			.40
Resistor 1% RN60D 604 ohm	1	920-360-40	IRC			.40
Resistor 1% RN60C 6.34K	1	920-463-41	IRC			.50
Resistor 1% RN60C 10K	1	920-410-02	IRC			.50
Resistor 1% RN60C 20K	1	920-420-02	IRC			.50
Resistor 1% RN60C 69.8K	1	920-469-82	IRC			.50
Resistor 1% RN60C 392.K	1	920-495-33	IRC			.50
Capacitor 22PF DISC	1	901-012-20				.10
Capacitor 100PF DISC	1	901-011-01				.10
Capacitor 220PF DURMICA	1	915-032-21	Duramica	DM15-221J		.65
Capacitor 220PF DISC	10	901-012-21	RMC	JL220		.10
Capacitor .001 DISC	9	900-081-03	RMC	BA-001		.10
Capacitor .0047 MYLAR	1	912-074-72	Elpac	2D5A472J		.90
Capacitor .01 DISC	9	900-021-04	RMC	TA.01		.10
Capacitor .033 POLYSTYRENE	1	913-033332	Elpac	PD5A333		2.10
Capacitor .068 POLYCARBONATE	1	911-036-83				2.40
Capacitor .22MFD POLYCARBONATE	2	911-032-24				1.35
Capacitor .82MFD POLYCARBONATE	1	911-038-24				3.85
Capacitor 1MFD TANTALUM	2	916-010-05	Sprague	196D105X0035H		1.25
Capacitor 22MFD TANTALUM	1	916-220-05	Sprague	196D226X0015K		3.50
Capacitor 100MFD/250V	1	910-061-07	Sprague	39D107F250HL4		4.50

DESCRIPTION	QTY.	DORIC P/N	MFG & P/N		REC SPARES	UNIT PRICE
Capacitor 8000MFD/15V	1	910-801-15	Sprague	39D808G0155T4		6.25
Capacitor 250MFD/25V	2	910-250-25	Mallory	MTV250DN25		1.65
Potentiometer 5K	3	960-015-02	Centralab	Series 4TR		1.25
Potentiometer 10K	2	960-011-05	Electra	ET34P 102-004		5.05
Heatsink	1	100-227-02	Doric	100-227-02		1.10
Buss Bar	7	992-010-60				1.50
Transformer 455KHz	1	100-703-01	Doric	100-703-01		1.50
Nixie	3	968-060-01	Burroughs	B57505	1	13.40
Nixie Socket	3	992-002-01	Burroughs	SK207		1.50
Neon Type E	1	968-010-03		NE2E		.60
Signal Light	1	968-010-05	Signalite	A261		2.30
Fuse 1½A SLO-BLO Pigtail	1	971-070-00	Littelfuse	31501.5	1	1.25
PWR Transformer	1	300-710-04	Aztec	12070		45.00
Board Guide, Extruded	1 set	500-204-XX	Doric	500-204-XX		10.00
Rear Panel	1	500-205-XX	Doric	500-205-XX		15.00
Shield	1	500-208-XX	Doric	500-208-XX		24.00
Front Panel	1	500-211-XX	Doric	500-211-XX		11.00
Name Plate	1	500-216-XX	Doric	500-216-XX		5.00
Thermal Shunt	1	500-217-XX	Doric	500-217-XX		5.00
Chassis	1	500-222-XX	Doric	500-222-XX		64.40

parts list DS500

DESCRIPTION	DORIC STOCK NO.	QTY.	REC. SPARE
100 pf disk capacitor	901-011-01	1	
220 pf Duramica	915-032-21	1	
220 pf disk capacitor	901-012-21	9	
.001 mfd disk capacitor	900-081-03	9	
.0047 mfd disk capacitor	912-074-72	1	
.01 mfd disk capacitor	900-021-04	9	
.033 mfd polystyrene capacitor	913-033-32	1	
.068 mfd polycarbonate capacitor	911-036-83	1	
.18 mfd polycarbonate capacitor	911-081-84	1	
.22 mfd polycarbonate capacitor	911-032-24	1	
.82 mfd polycarbonate capacitor	911-038-24	1	
1 mfd tantalum capacitor	916-010-05	2	
22 mfd tantalum capacitor	916-220-05	1	
100 mfd/250V capacitor	910-061-07	1	
8000 mfd/15V capacitor	910-801-15	1	
250 mfd/25V capacitor	910-250-25	2	
5K pot	960-015-02	1	
10K pot	960-011-05	2	
Heatsink	100-227-02	1	
Buss Bar	992-010-60	7	
Nixie	968-060-01	3	
Socket, Nixie	992-002-01	3	
Neon	968-010-03	1	
Signal Light	968-010-05	1	

DESCRIPTION	DORIC STOCK NO.	QTY.	REC. SPARE
Fuse, 1½ amp slo-blo	971-070-00	1	
Fuse, .25 amp slo-blo	971-010-01	1	
Slider shield	500-208-XX	1	
Fuse Holder	971-080-01	1	
Transformer, Power	300-710-04	1	
Switch	969-100-05	1	
Chassis	500-222-00	1	
Knob	100-221-XX	1	
Logo	500-219-XX	1	
Nameplate	500-216-XX	1	
Power cord	993-200-05	1	
Front Panel	500-211-XX	1	
Plastic Board Guide	500-204-XX	2	
Circuit Board	500-210-XX	1	
SN74141 I.C.	965-521-00	3	1
SN7475 I.C.	965-517-00	3	1
SN7490 I.C.	965-518-00	4	1
SN74107 I.C.	965-520-00	7	1
SN7402 I.C.	965-516-00	8	1
SN7493 I.C.	965-519-00	1	
MC840P I.C.	965-522-00	1	
2N3415 Transistor	962-341-50	1	
2N3393 Transistor	962-339-30	7	2
2N3877A Transistor	962-387-71	5	1
2N4250 Transistor	962-425-00	3	1
2N3638 Transistor	962-363-80	2	
2N5296 Transistor	964-529-60	1	
MCR406-1 Rectifier	966-002-10	1	
CMC5133 Rectifier	965-523-00	2	
2061 F.E.T.	100-729-00	1	

DESCRIPTION	DORIC STOCK NO.	QTY.	REC. SPARE
1742 F.E.T.	100-722-00	4	1
SU2211 F.E.T.	100-724-00	4	1
455KHz Transistor	100-703-01	1	
741 Op Amp	965-506-00	1	
IN914 Diode	961-091-40	28	2
IN457 Diode	961-045-70	1	
IN702 Diode	961-070-20	1	
IN751 Diode	961-075-10	1	
SCE2 Rectifier	966-002-00	4	
SCE6 Rectifier	966-002-04	1	
68 ohm ¼W 5% Carbon Resistor	942-206-80	2	
150 ohm ¼W 5% Carbon Resistor	942-201-51	5	
390 ohm ¼W 5% Carton Resistor	942-203-91	4	
1K ohm ¼W 5% Carbon Resistor	942-201-02	7	
1.5K ¼W 5% Carbon Resistor	942-201-52	4	
2.2K ¼W 5% Carbon Resistor	942-202-22	2	
6.2K ¼W 5% Carbon Resistor	942-206-22	1	
4.7K ¼W 5% Carbon Resistor	942-204-72	11	
8.2K ¼W 5% Carbon Resistor	942-208-22	1	
10K ¼W 5% Carbon Resistor	942-201-03	14	
12K ¼W 5% Carbon Resistor	942-201-23	1	
15K ¼W 5% Carbon Resistor	942-201-53	2	
22K ¼W 5% Carbon Resistor	942-202-23	13	
39K ¼W 5% Carbon Resistor	942-203-93	1	
47K ¼W 5% Carbon Resistor	942-204-73	1	
68K ¼W 5% Carbon Resistor	942-206-83	6	
75K ¼W 5% Carbon Resistor	942-207-53	1	
100K ¼W 5% Carbon Resistor	942-201-04	3	

DESCRIPTION	DORIC STOCK NO.	QTY.	REC. SPARE
120K ¼W 5% Carbon Resistor	942-201-24	2	
150K ¼W 5% Carbon Resistor	942-201-54	2	
220K ¼W 5% Carbon Resistor	942-202-24	1	
470K ¼W 5% Carbon Resistor	942-204-74	2	
680K ¼W 5% Carbon Resistor	942-206-84	1	
1 MEG ¼W 5% Carbon Resistor	942-201-05	2	
22K ½W 5% Carbon Resistor	942-302-23	4	
511 ohm 1% Resistor	920-351-10	1	
604 ohm 1% Resistor	920-360-40	1	
6.34 K 1% RN60C Resistor	920-463-41	1	
10K 1% RN60C Resistor	920-410-02	1	
18.2K 1% RN60C Resistor	920-418-21	1	
69.8K 1% RN60C Resistor	920-469-82	1	
953K 1% RN60C Resistor	920-495-33	1	
Reference Bd. Ass'y	500-405-01	1	

ZERO CROSSING CIRCUIT

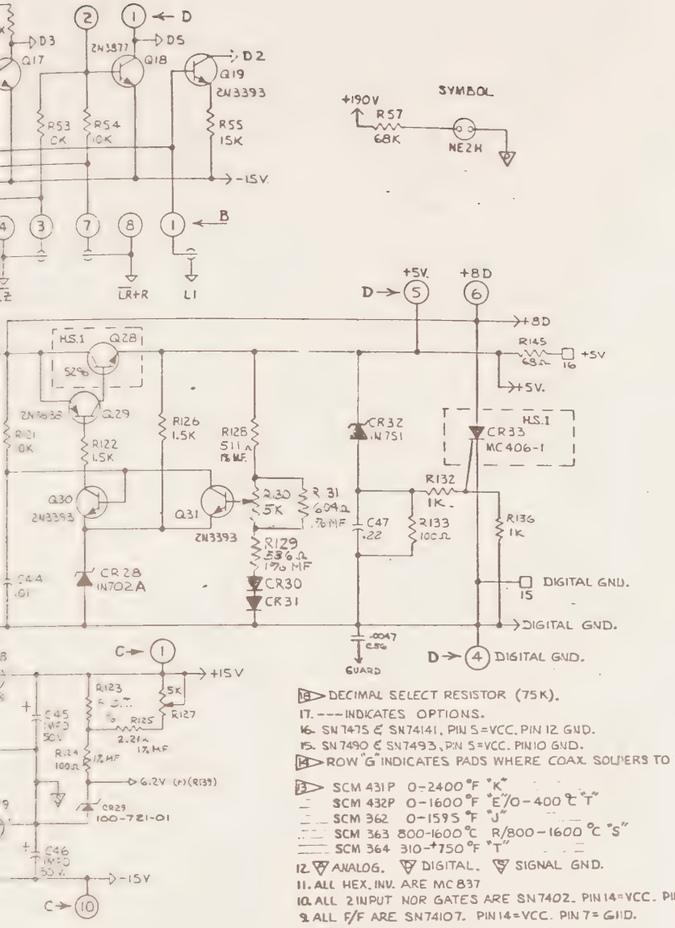
AUTO ZERO CIRCUIT

REF. CIRCUIT

80KHz CLOCK

REFERENCE DESIG

REF. DES.	LAST USED	DELETED
R (RES.)	149	39, 147
C (CAP.)	57	
CR(DIODE)	34	29
Q (TRANS)	31	6
Z (I.C.)	40	
T.P.	7	



13. ▷ DECIMAL SELECT RESISTOR (75K).
17. --- INDICATES OPTIONS.
16. SN7475 & SN74141, PIN 5 = VCC, PIN 12 GND.
15. SN7490 & SN7493, PIN 5 = VCC, PIN 10 GND.
14. ▷ ROW "G" INDICATES PADS WHERE COAX. SOLDERS TO BD.

13. ▷ SCM 431P 0-2400°F "K"
— SCM 432P 0-1600°F "E" / 0-400°C "T"
— SCM 362 0-1595°F "J"
— SCM 363 800-1600°C R/800-1600°C "S"
— SCM 364 310-+750°F "T"

12. ▽ ANALOG. ▽ DIGITAL. ▽ SIGNAL GND.
11. ALL HEX. INV. ARE MC 837
10. ALL 2 INPUT NOR GATES ARE SN7402. PIN 14 = VCC. PIN 7 GND.
9. ALL F/F ARE SN74107. PIN 14 = VCC. PIN 7 = GND.
8. ◎ INDICATES TEST POINT.
7. → OR ▷— INDICATES INTERNAL CONNECTION.
6. —□ INDICATES J1 CONNECTION.
5. ROW "B". ALL EVEN NUMBERS (EXCEPT #2) ARE DIGITAL SIDE.
4. ○ INDICATES ELCO. A → INDICATES ROW.
— A = MATRIX BD.
— B = I.O. BD.
— C, D, E, F } SET-POINT OPTION T2 BOARD.
3. CAP VALUES ARE μF UNLESS OTHERWISE SPECIFIED.
2. RESISTOR ±5% 1/4W.
1. ALL DIODES IN914

NOTES: (UNLESS OTHERWISE SPECIFIED)

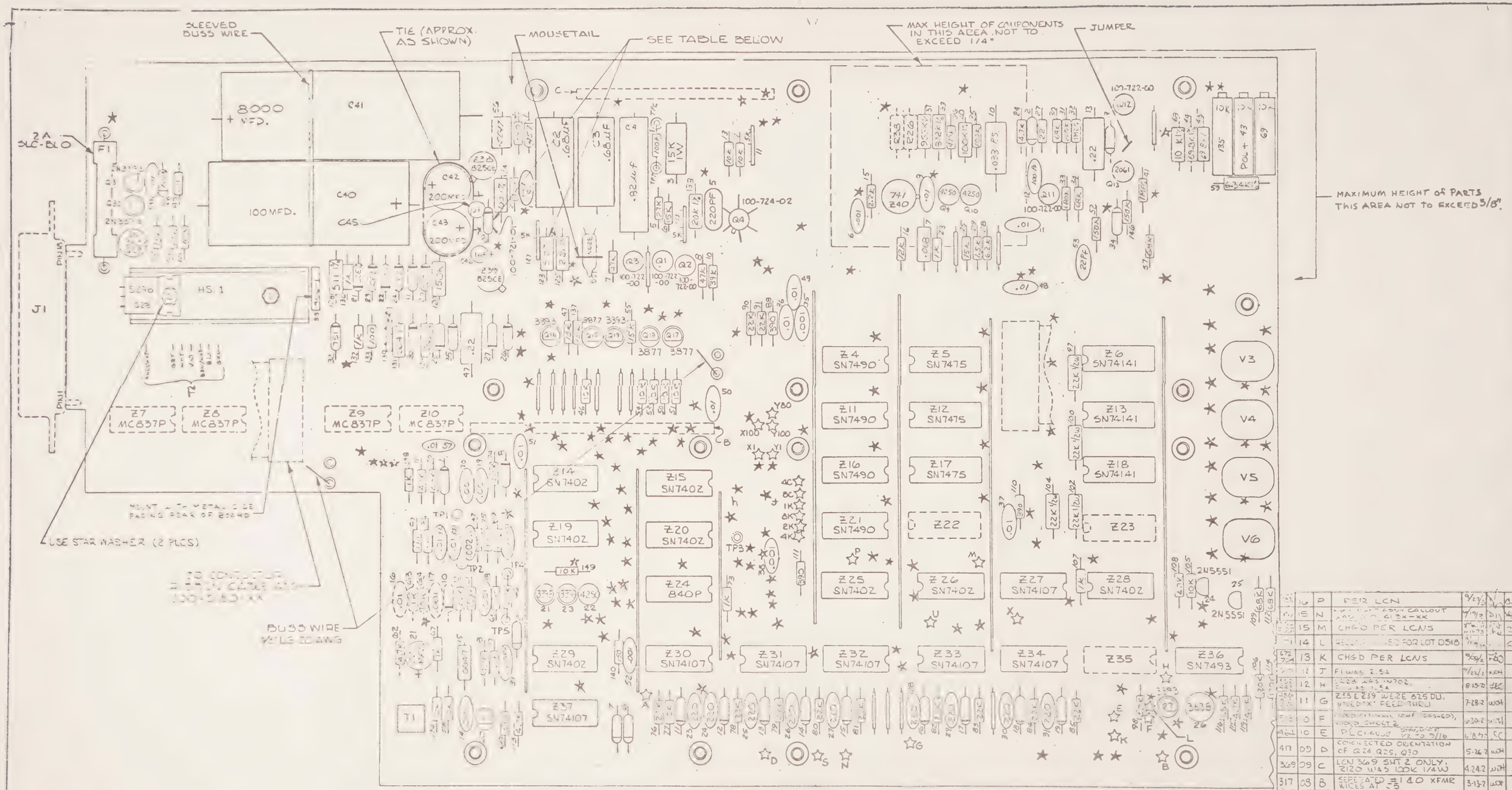
637 704	05	F	ADDED C57, RM6, M7, M8
610	09	E	F1 WAS 2.5A
443 552	04	D	CHANGE CR28 FROM IN702 TO IN702A
535	04	C	738 & 739 WERE 825 DU
369	04	B	LCN 369 SHT 2, R120 WAS 100K ¼W
246	3	A	PER LCN

DORIC SCIENTIFIC CORPORATION

SCHEMATIC DIAGRAM
DS 300/500-T3

2/24/71

300-657-01



	16	P	PER LCN	9/27/73	AC
	15	N	ADD'L CKT ADDED CALLOUT AS "C" IS 3X-XX	7/19/73	DH
	15	M	CHG'D PER LCN'S	5/23/73	AC
	14	L	REVISED FOR LOT D518	5/11/73	AC
	13	K	CHG'D PER LCN'S	3/30/73	JBO
	12	J	F1 WAS 2.5A	1/23/73	WSH
	12	H	Z22A WAS SN7402, Z23 WAS 1.6A	8-15-72	JBC
	11	G	Z35 E 239 WERE 825 DU, WIREDX' FEED THRU	7-28-72	WSH
	10	F	ADDITIONAL CKT DESIGN, SEE SHEET 2	6-30-72	WSH
	10	E	PC CHANGE V2 TO 9/16	6/8/72	CC
417	09	D	CORRECTED ORIENTATION OF Q24 Q25, Q30	5-26-72	WSH
369	09	C	LCN 369 SHT 2 ONLY R120 WAS 100K 1/4W	4-24-72	WSH
317	08	B	SEPARATED #1 & 0 XFMR WIRES AT J5	3-13-72	WSH
296	05	A	CHANGED PART NO. Q24, 25, ECLW PN14 TO 13 +5 TO +5V.	1/9/72 11/18/71	WSH CC
—	07	—	ADDED 100MF CAP IN P.S. ETC.	10--	CC
—	06	—	USED MC 330 T2 ONLY	—	—
—	05	—	ONLY SOC 330 COM PTS SHN		

DYNAC SCIENTIFIC

MOTHER BOARD ASSY D3500-T3, D3500-T3 OR D3520-T3

D. SMITH	8-3-71	
D. SMITH	8-3-71	
D. SMITH	8-3-71	

SCALE: 1 1/2 | SIZE: D | 3500-4-XX | REV: P

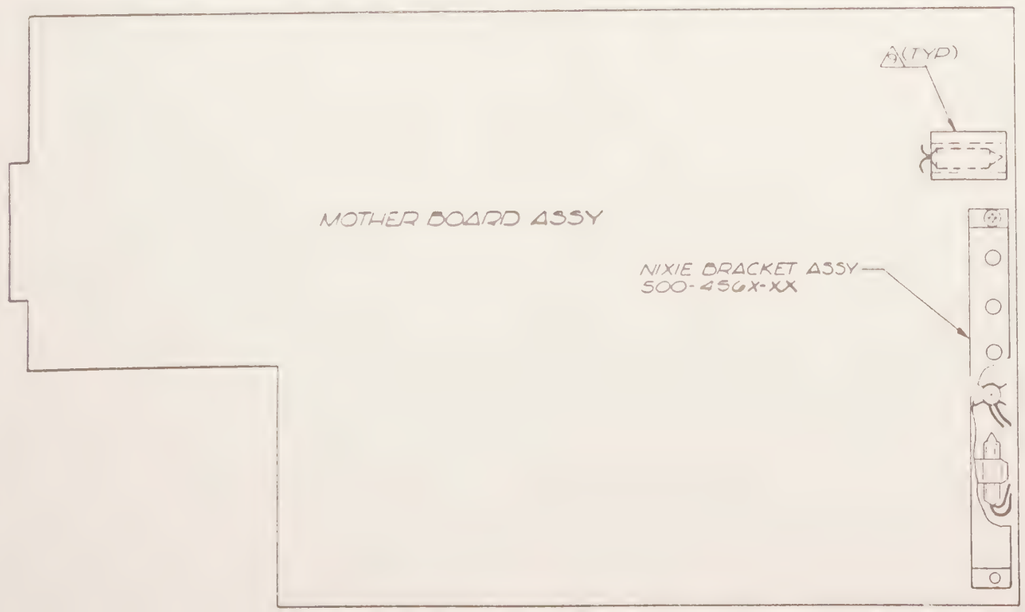
[illegible]	2.49K 1%
[illegible]	1.78K 1%
5.1MA TO 6.1MA	[illegible]
6.2MA TO 8.7MA	1.27K 1%
8.8MA TO 9.9MA	1.21K 1%
ZENER CURRENT (CR29)	9.1V 3

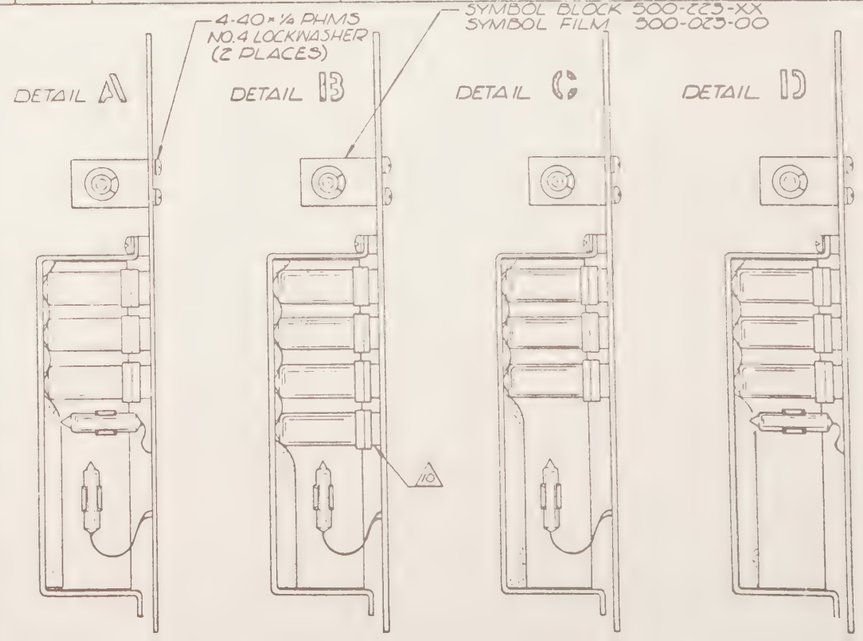
5. FOR BASIC BOARD DO NOT INSTALL DASHED COMPONENTS OR ☆ FEEDTHRUS, SHEET 2 OF THIS DWG COVERS THEIR INSTALLATION.
4. ☆ INDICATES FEED-THRU
   ☆ INDICATES PROGRAMMED FEED-THRU. SEE NOTE 5.
3. DIODES ARE IN914
2. ⊖—⊖ INDICATES JUMPER
1. RESISTOR VALUES ARE IN OHMS RESISTORS ARE CARBON, 1/4W, ±5%

NOTES: UNLESS OTHERWISE SPECIFIED

TABULATION

ASSEMBLY P/L NO				STENCIL SHEET P/L NO	COMPONENT INSTALLATION R26	R39	Z22	Z23	Z35	DIGITRONICS INDICATED ☆	READOUT DETAIL	REMARKS
500-4100-XX			-XX									
-4101-			-50	500-441-XX	100K	16.9K			794D	Y100, H, E, B, P, A, 2K	A	
-4102-			-02									
-4103-			-250									
-4104-			-50	500-442-XX	61.9K	11.3K			797D	Y80, L, F, H, B, P, A, 2K	A	
-4106-			-02									
-4107-			-250									
-4108-			-502	500-440-XX	39.8K	11.3K			795D	Y80, H, B, E, 8C	C	
-4109-			-02									
-4110-			-501									
-4111-			-50	500-443-XX	55.6K	8.25K	SN7475	SN74141	796D	Y80, X100, 4K, M, G, X, F, K, U, A	B	ADD 4TH NIXIE SOCKET IN POSITION "V6" ⑩
-4112-			-02									
-4113-			-501									
-4114-			-502	500-439-XX	100K	16.9K			795D	Y100, H, B, P, A, 2K	A	
-4118-			-02									
-4119-			-502									
-4120-			-50	500-438-XX	46.4K	2.21K			798D	Y80, X1, N, S, H, D, 8C	C	REMOVE EXISTING R39 (39.2K) REPLACE WITH R39 (165K RN60C 1%)
-4122-			-02									
-4123-			-501									
-4124-			-502	500-437-XX	32.5K	5.35K			794D	Y1, H, B, 4C	C	
-4126-			-02									
-4127-			-502									
-4128-			-501									
-4130-			-02	500-436-XX	34.8K	5.49K			793D	Y80, H, E, B, P, A, 2K	D	
-4131-			2501									
-4132-												
-4133-			-5301									
-4134-			-02	500-435-XX	34.8K	5.49K			793D	Y80, H, B, P, A, 2K	D	
-4135-			-5501									
500-4150-XX												





NOTES:

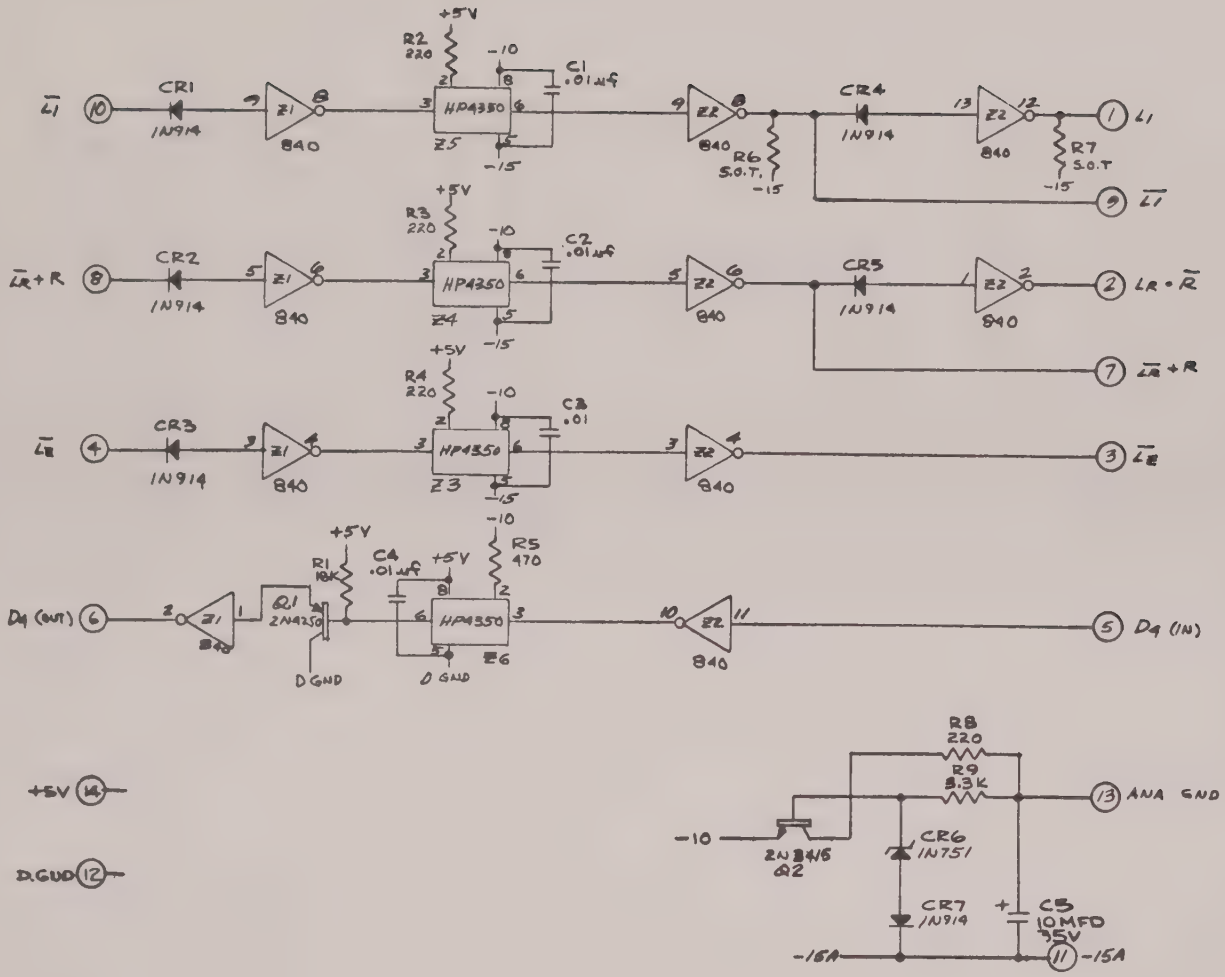
⑥ FOR OPTION 56P (ISOLATED BCD OUTPUT) ADD THE FOLLOWING: C16, C17, R62, R63, R64, CR10, Z7, Z8, Z9, Z10, J1, ROW "D" ELCO PINS (DELETE RESPECTIVE FEEDTHRUS) & RIBBON CABLE ASSY; PER P/L 500-447-XX.

⑦ FOR OPTION 57 (ANALOG OUTPUT) ADD J1, ROW "C" ELCO PINS

⑧ FOR OPTION 59 (ALARM SET POINT) ADD J1, ROW "C" ELCO PINS

⑨ SYMBOL BLOCK, SYMBOL FILM & NEON USED ONLY ON:
DS-300-T3-56D,
DS-300-T3-57 OR
DS-300-T3-56P-57

500-4XXX-XX Rev. P



803	07	B	ADDED C5	5-21-73	GO
711	06	A	REDESIGN	1-5-73	

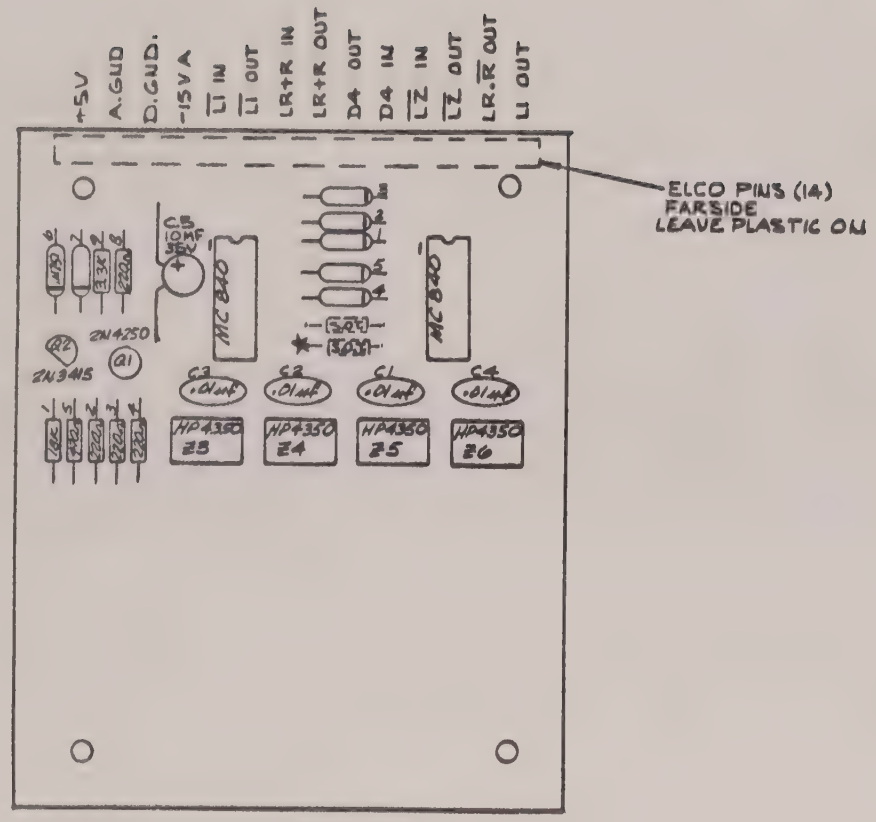
DORIC SCIENTIFIC COR AARON

SCHEMATIC -OPTION S6P. ISOLATED BCD OUTPUTS.

5-21-73 SHT. 1 OF 1 300-625-07 B

2. B2 PIN 7 -15V. PIN 14 -10V
1. Z1, PIN 7 D GND. PIN 14 +5V

NOTES:



NOTES: (UULESS OTHERWISE SPECIFIED)

1. (•) INDICATES PIN 1 ON I.C. & CATHODE END OF DIODE.
2. DIODES IN914
3. ✱ INDICATES FEEDTHRU.

807	10	D	ADDED C5	521-3	GD
711	09	C	REDESIGN	1-5-73	JDC

DORIC SCIENTIFIC COMPANION

TITLE: ASSY-OPTION 56P. ISOLATED BCD OUTPUTS

DRN J. Crattie 1-8-73

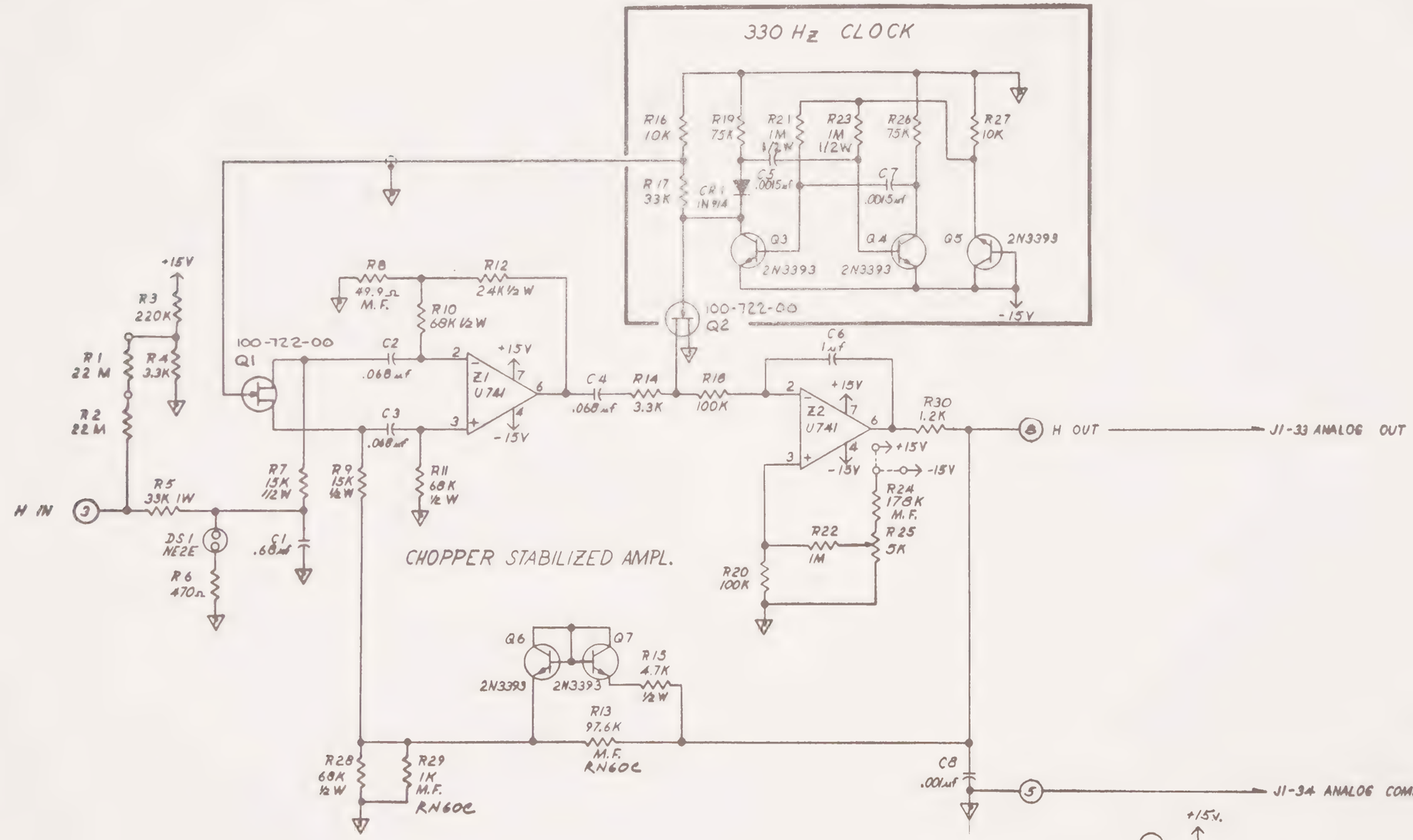
CHKD

APPD J. Crattie 1-8-73

MFG APPR. C. CAPISTRAN 8-1-73

SHT 1 OF 1

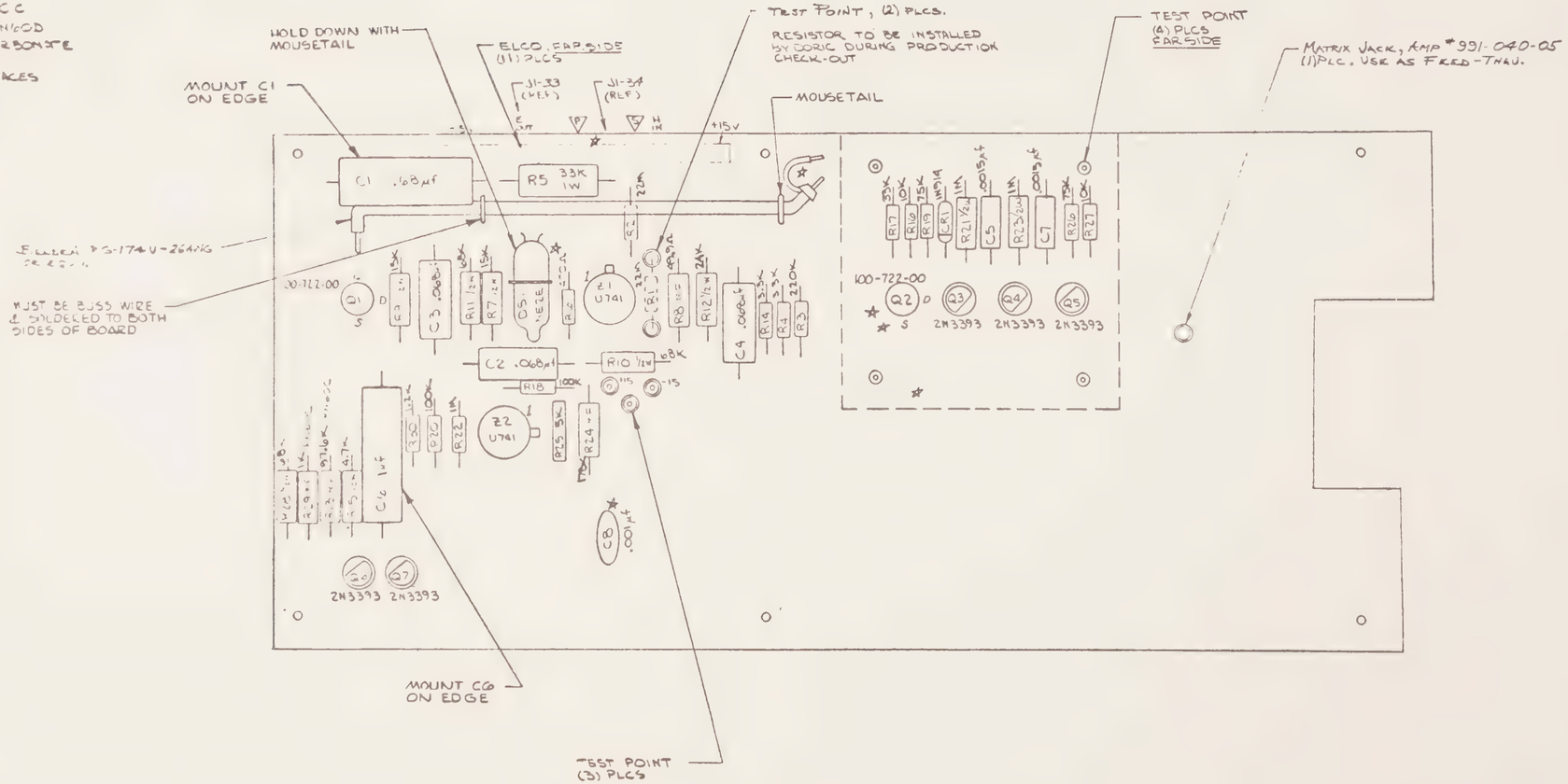
300-425-10 D



. ALL M. F. ARE ±1% RN60D
. ○ INDICATES ELCO.
. ▽ POWER GND.
. ▽ SIGNAL GND.
. ALL CAPACITORS POLYCARBONATE 50 WVDC ±20%.
. ALL RESISTORS ±5% ½W.
OTES: UNLESS OTHERWISE SPECIFIED.

02	TWO 22 MΩ; TEMPCO GAIN STORAGE	
DORIC SCIENTIFIC CORPORATION	SCHEMATIC DIAGRAM — ANALOG OUTPUT OPT. 57	
DRAWN DYNA PAC 8-24-71		
CHKD		
DES.	MFG ASSY.	SCALE
APPD 18 Oct 71		SIZE
DATE	SHT. 1 OF 1	DWG NO 300-632 02

NOTES
UNLESS OTHERWISE SPECIFIED)
1. ALL RESISTORS ARE 1/4W 5% C.C
2 ALL MF RESISTORS ARE 1%, RN/60D
3 ALL CAPACITORS ARE POLYCARBONATE 50 VDC 20%
4 * INDICATES FEED-THRU 7 PLACES
5 (P) POWER GND
6 (▽) SIGNAL GND



03 CLK SHIELD ADDED

ASSEMBLY DIAGRAM
ANALOG OUTPUT OPTION S7

DYNA-PRO B-28

SCHEM 300-632-02 2/1

300-432 03

330 Hz CLOCK

CHOPPER STABILIZED AMPL.

TRIGGER

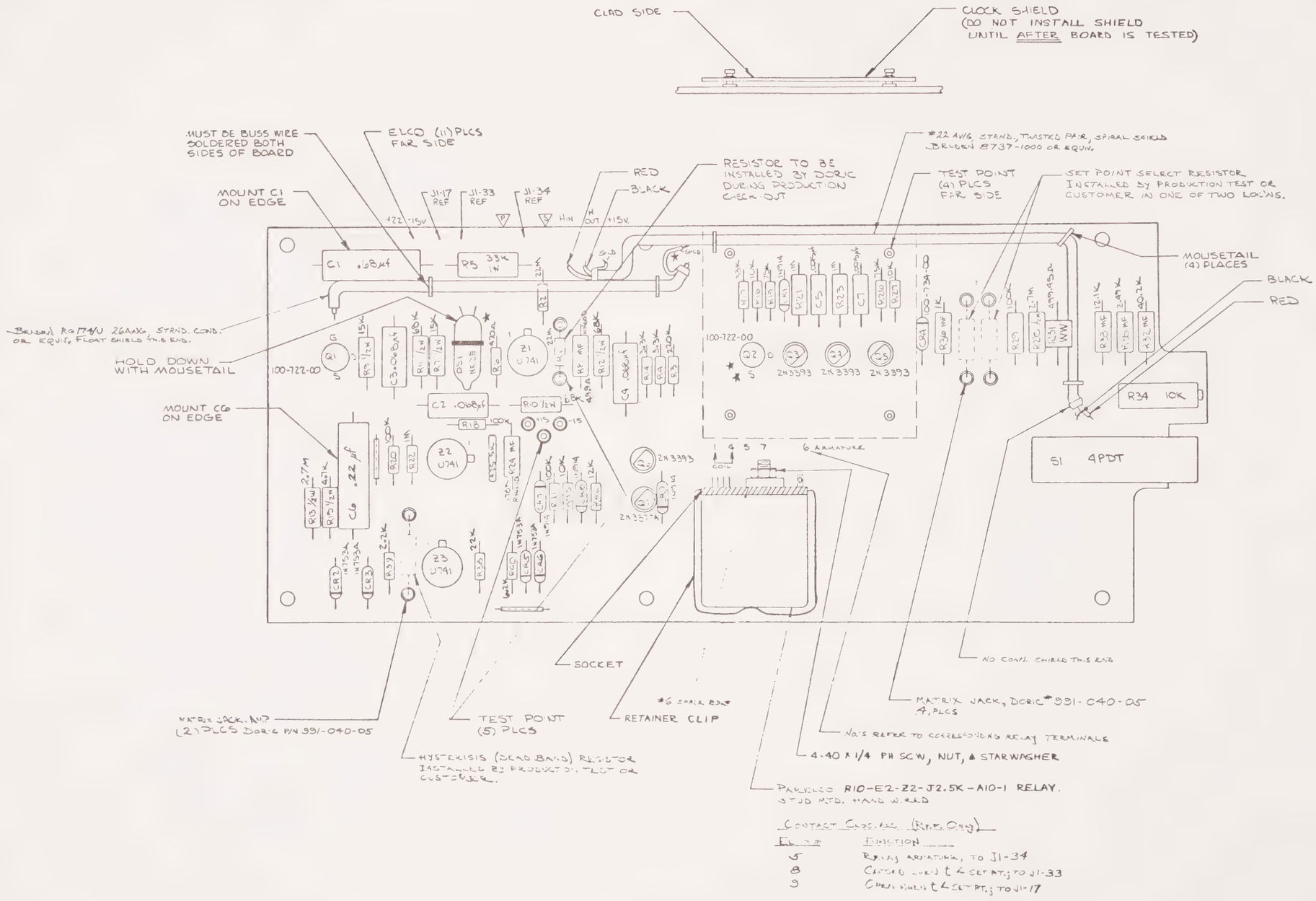
11. ⊛ INDICATES TEST POINT.
10. ▷ SEE HYSTERISIS TABLE FOR VALUE.
9. ▷ FOR R & S USE 1% 3.32K .05% W.W.
8. ▷ SEE REF. NETWORK TABLE FOR VALUE.
7. ▷ FOR R & S USE 499K ¼ W.
6. ALL M. F. ARE 1% RN60C.
5. ◯ INDICATES ELCO
4. ▽ POWER GND.
3. ▽ SIGNAL GND.
2. ALL CAPACITORS POLYCARBONATE 50 WVDC ±20%.
1. ALL RESISTORS ±5% ¼ W.

NOTES: UNLESS OTHERWISE SPECIFIED.

DORIC SCIENTIFIC

SCHEMATIC DIAGRAM - ALARM SET POINT W/CLOSURE OPTION 53

300-628 03



NOTES:
(UNLESS OTHERWISE SPECIFIED)
1. ALL RESISTORS ARE 1/4W, 5%, CC.
2. ALL M.F. RESISTORS ARE 1%, RN60C
3. ALL CAPACITORS ARE POLYCARBONATE, 50 WVDC, 20%
4. * INDICATES FEEDTHRU (4) PLCS
5. ▽ POWER GND
6. ▽ SIGNAL GND

CONTACT CHGS. REQ. (REF. ONLY)

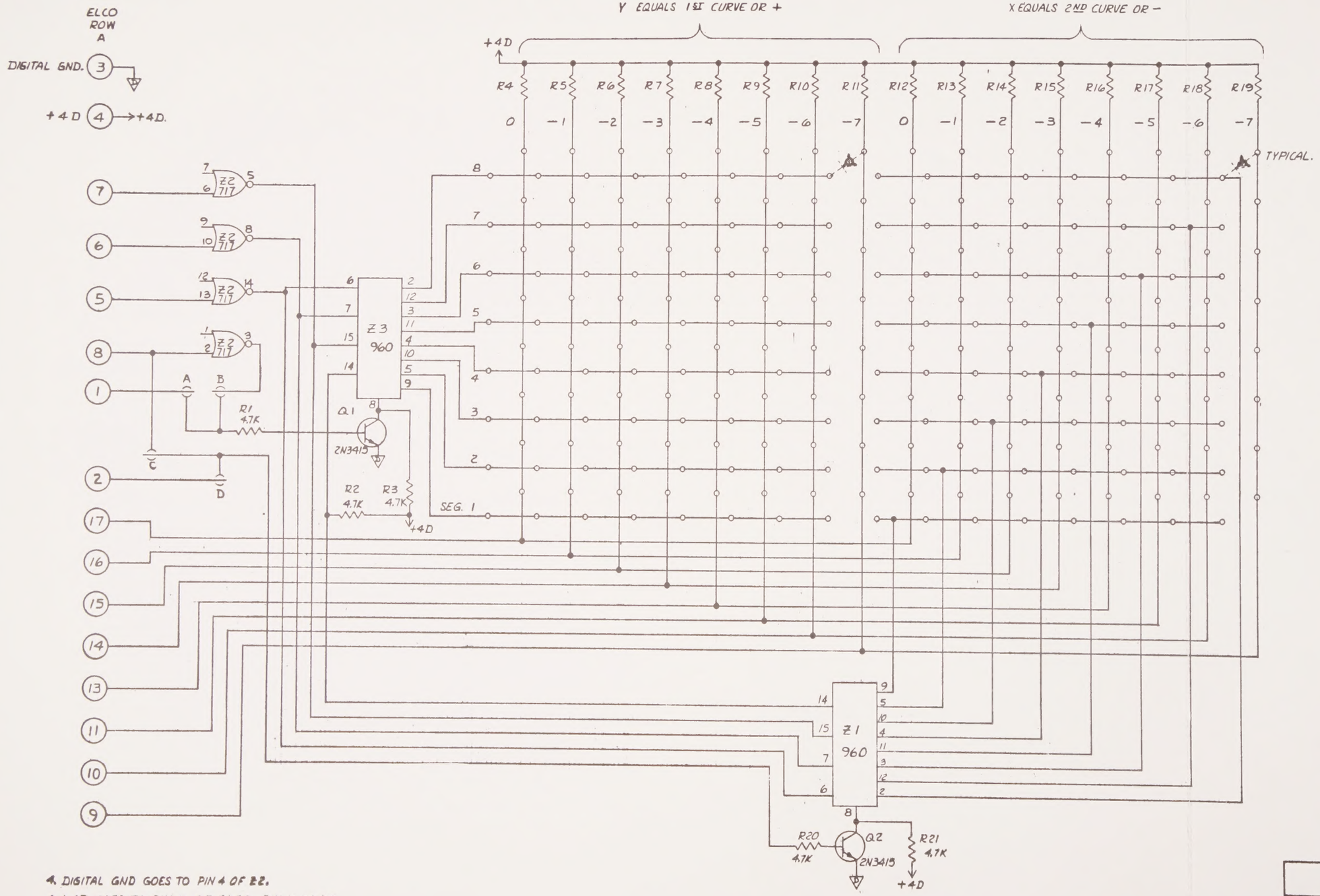
FROM	FUNCTION
5	RELAY ARMATURE, TO J1-34
8	CLOSED WHEN t < SET PT.; TO J1-33
9	OPEN WHEN t < SET PT.; TO J1-17

627	05	–	CHG'D RELAY	11-4-2	
	04	–	ADDED NOTE 5 & 6 REVISED SWITCH, S1 CLEARANCE	1-17-2	

ASSEMBLY DIAG -
ALARM SET POINT W/ CLOSURE
OPTION 59

SCHEM 300-628-03

300-428-05



NOTES: (UNLESS OTHERWISE SPECIFIED)

1. DIGITAL GND GOES TO PIN 4 OF Z2.
2. +4D GOES TO PIN 16 OF Z1 & 3. PIN 11 OF Z2
3. ⏚ INDICATES SELECTION PAD.
4. RESISTORS 100K ±5% 1/4 W.

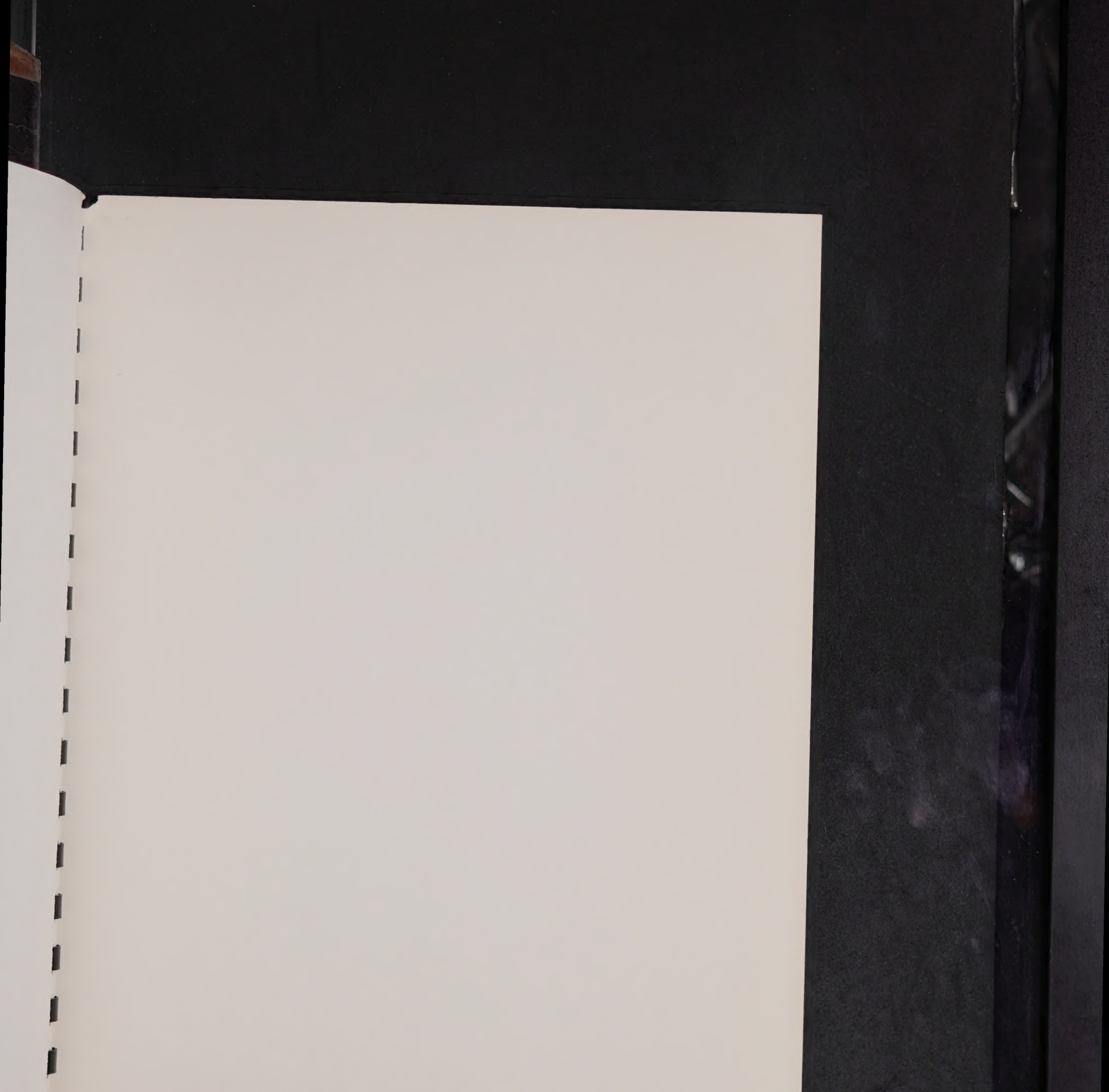
DORIC SCIENTIFIC CORPORATION

SCHEMATIC DIAGRAM
MATRIX BD. DS-300

DRAWN P. Cabrera 10-10-70
CHECK
DESIGN
RELEASE
APPROVAL DATE

SHT. 1 OF 1

300-602 00



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